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River otter population status and habitat use in northwestern Montana

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RIVER OTTER POPULATION STATUS AND HABITAT USE

IN NORTHWESTERN MONTANA

BY

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ABSTRACT

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River Otter Population Status and Habitat Use in Northwestern Montana

Directors: Dr. Daniel Pletscher and Dr. Lee Metzgar

River otter (Lutra canadensis) population status and habitat use was investigated in northwestern Montana from July 1985 through July 1987. Latrine sites in the Flathead River valley (FRV) were surveyed during spring to obtain an index of use and to identify associated habitat characteristics. The number of scats decreased significantly between the first and last surveys, particularly in sloughs. Preferred sites for latrines were in moderate to dense shrubs, on concave shorelines with steep underwater banks, adjacent to obstructions and pools in the waterway, and close to confluences and beaver lodges. A discriminant function analysis (DFA) model using bank slope, water depth, distance to nearest beaver lodge, percent pools, waterway obstructions, and site accessibility, correctly classified 85% of the latrine sites and 73% of the available sites. Reproductive condition, dispersal, and water levels may have influenced otter behavior or densities causing variations in scat deposition. Habitat characteristics at latrine sites reflect an otter's energy and security needs. The DFA model should aid in locating latrine sites in the FRV but requires further testing for use elsewhere.

Radioisotopes, impregnated into polylactic acid (PLA) tablets and implanted in otters, were evaluated as a marker of river otter scats for potential use with the mark-recapture technique to estimate population size. Four otters were implanted with PLA tablets containing 15 -20 μCi of ^{65}Zn, ^{54}Mn, or ^{57}Co. Scats (n=371) were collected during 5 recapture periods 6 to 8 months later. Three detection methods failed to find radioactivity in the scats. Failure to detect marks may have been due to radioisotope quantity and decay schedule, the PLA implant delivery system, or the make-up and durability of the scat.

Habitat components used by otters during gestation, lactation, and breeding were investigated using radio locations obtained from 5 otters. Spring home range length varied from 4 km for a female to 31 km for a male. Otters preferred areas with waterway obstructions, longer shoreline lengths, and few disturbances, and avoided areas with ≤ 25% understory cover. Females also preferred waters with higher percentages of pools. A DFA model using obstructions in the waterway, shoreline length, pools, and understory cover, correctly separated spring otter use from available habitat in 75% of the cases. A DFA model using spring location data from female otters correctly classified 91% of the female cases using the same 4 variables. The significance of spring habitat use and of the DFA model is discussed.

Surveys were conducted on 450 km of waterways to determine general habitat use and distribution. Rivers were rated for otter habitat suitability based on factors identified in the FRV as preferred. Otter sign was infrequent but 4 of 5 sign locations occurred on rivers with among the highest ratings.

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THESIS INTRODUCTION

River otters (Lutra canadensis) were once distributed throughout North America with greater population densities in areas with high concentrations of wetlands (Jenkins 1983). Beginning in the 1600's, fur trapping, habitat destruction, and water pollution caused major population declines (Hill 1978, Jenkins 1983, Toweill and Tabor 1982). By the mid 1900's, otters were protected by many states and some populations increased significantly. The otter harvest in North America nearly tripled between 1965 and 1980 and in 1983, 50,000 otters were harvested from 26 states, primarily in the Southeast (Deems and Pursley 1983). The low occurrence of otters in other areas has led to reintroduction efforts in 13 states (Melquist and Dronkert 1987, M. Moretti, pers. commun.). Otters are protected in 17 states and considered extinct in 7 (Deems and Pursley 1983).

Inclusion of the taxa Lutrinae in 1977 on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulated international trade in river otter pelts (Hill 1978). This required states to justify otter management (Halbrook 1978), leading to an increase in research efforts; between 1977 and 1984, 55 river otter studies were ongoing in 39 states and 5 provinces (W. Melquist, pers. commun.).

Current otter management employs a wide range of tactics including sustained harvest in Louisiana (G. Linscombe, pers. commun.), a ban on trapping in California (K. Reeves, pers. commun.), special permits and a one otter limit in New Jersey (Anon. 1984), and reintroduction in Colorado

(Dronkert 1982). In Montana, 7 years of closed seasons, begun in 1949, resulted in larger otter populations and a one otter limit was initiated in 1956. Subsequently, a reported average of 45 otters have been trapped annually, mainly in western Montana (Zackheim 1982, Hash 1986).

Trapping data from a number of states shows a positive correlation between the numbers of otter and beaver trapped. Recent harvest ratios were 1 otter for every 6-10 beaver in the southeastern United States (Hill 1978) and 1 otter for every 320 beaver in Montana (Zackheim 1982). In a survey of Montana trappers, over 70% of the otter kills were incidental to beaver trapping (Zackheim 1982). Due to the otter's susceptibility to beaver traps, managers could expect increases in the number of otters trapped with increases in the beaver harvest even with closed otter seasons.

River otter population dynamics may be influenced not only by beaver trapping but also by wide fluctuations in beaver numbers and subsequent habitat changes. Several investigators have associated good otter habitat with the activities of beavers (Choromanski and Fritzell 1982, Melquist and Hornocker 1983, Anderson and Woolf 1984). In the western U.S., with widely separated waterways and large variations in flow, beaver-created habitat may be critical to otter denning and foraging.

Also potentially devastating to otter populations is the well documented destruction of riparian ecosystems. Twelve of 15 state wildlife agencies surveyed considered habitat destruction the primary factor preventing population recovery (Bottorff et al. 1976). In the West, mining, agriculture, livestock, urbanization, dam construction, logging, and water diversion projects have all been factors in the destruction of riparian areas (Crumpacher 1981).

The effect of water quality and quantity on river otters is not well understood. Minimum habitat components have been difficult to quantify. Researchers familiar with otters usually agree on optimum habitat features: slow moving waters with deep pools, abundant riparian vegetation, and a high biomass of forage fish (Melquist and Dronkert 1987). Wide ranging and opportunistic, otters can be found in many waterways that satisfy basic life requirements, but more research is needed on limiting factors in their habitat.

Otter populations may vary along a "behavioral scale" (Wilson 1975) or "territorial gradient" (Foy 1984), resulting in variable, flexible spacing strategies in relation to prey density and habitat (Hornocker et al. 1983). This has made it difficult to develop reliable census techniques for otters. Methods used to determine the status of otter populations include sign surveys, scent stations, harvest data, pelt registration, carcass examinations, mark-recapture, radio-telemetry, and sightings by lay persons.

A combination of techniques is recommended to obtain an index of distribution and numbers (Robson 1982, Foy 1984). Otter presence can be determined from sign surveys, but variations in the amount of sign have been attributed to changes in habitat and behavior, and not to density (Foy 1984, Melquist and Hornocker 1983, Kruuk et al. 1987). Scent stations are time-consuming and attract otters only infrequently (Humphrey and Zinn 1982, Robson 1982). Harvest data can be an important management tool when used over the long term with adjustments for bias and in addition to other indicators of population status (Erickson 1982).

Restricted trapping is often necessary in states with small otter populations but small sample sizes may reduce data validity (Strickland and Douglas 1981). Mark-recapture techniques are impractical due to a low capture rate. Radioisotopes can be detected in the feces of animals marked with radioisotope tracers and marked scats can then constitute the "recapture" (Kruuk et al. 1980, Knaus et al. 1983). Scats can be collected throughout a study area and the ratio of marked to unmarked scats can be used to estimate the number of otters.

This study investigates the status, distribution, and habitat use of river otters in northwestern Montana. The substantive problem is to fulfill the CITES agreement which requires the Montana Department of Fish, Wildlife and Parks to justify current otter management.

Objectives:

1. Investigate otter distribution and associated habitat on waterways in northwestern Montana.

2. Using radio telemetry and radioisotope markers, determine distribution, home ranges, and number of otters in the Flathead River valley study area.

3. Discriminate habitat use from availability based on spring latrine sites and radio locations to identify factors important to otters in the study area during gestation, lactation, and breeding.

Surveys to fulfill objective #1 were conducted on 450 km of waterways in northwestern Montana (Appendix A). River otter sign was recorded and habitat value ratings (HVR) were determined for 21 streams. Sign was found only on 7 streams, hence it was difficult to associate HVR with the occurrence of otter sign. Four of the 5 streams with the highest

HVR had sign. The 9 streams with the lowest HVR showed no evidence of use by otters. River otters are wide ranging so absence of sign during a single survey does not verify absence of otters from a stream. Lack of sign over large areas of apparently suitable habitat should be viewed with concern. Conversations with residents and trappers on the Swan and Bitterroot rivers indicate that otters have been largely absent for the last 50 years. Historic beaver trapping is believed to be the cause of small, disjunct otter populations (B. Moore pers. commun.) and present day beaver trapping may continue to restrict otter populations.

The Flathead River valley above Flathead Lake had a high HVR, and reports indicated the area was supporting a relatively high number of otters. My previous research on otter habitat led me to believe this valley could be a core population center from which suitable, unoccupied habitat in could be recolonized.

Identifying otter use areas is important for population monitoring and conservation. Use areas may be influenced by food resources, waterway type, den sites, water levels, and cover. Home range and habitat use data from the Flathead River Valley could be used to protect local populations and habitat and could help to better define space and habitat requirements throughout Montana. This information can be taken into account when setting trapping regulations, in resource development plans, and for mitigation measures. A greater understanding of otter ecology can provide the framework for effective river otter conservation and management throughout Montana.

CHAPTER I

RIVER OTTER USE AND HABITAT CHARACTERISTICS OF LATRINE SITES IN SPRING IN THE FLATHEAD RIVER VALLEY, NORTHWESTERN MONTANA

INTRODUCTION

The North American river otter (*Lutra canadensis*), while not a federally listed threatened or endangered species, is on several such state lists. Concern over the status of the European river otter (*Lutra lutra*) led to the inclusion of the similar, North American river otter in Appendix II of the CITES (Convention on International Trade in Endangered Species) Treaty of 1977. This required a formal investigation of population trends, harvest, distribution, and habitat (Halbrook 1978). Montana lists the otter as a furbearer but imposes a one-otter limit per season. The average, reported statewide harvest is approximately 45 animals with most taken from western Montana (Zackheim 1982).

River otter latrine sites are often located in areas of increased otter activity called activity centers (Melquist and Hornocker 1983). These sites may also function to communicate reproductive condition and otter use of an area. An understanding of use and habitat characteristics of latrine sites can aid river otter management in 3 primary ways. First, variations in the numbers of scats could be used as an index of relative use. Second, identification of vegetative and physical characteristics at latrine sites would further our understanding of otter habitat requirements. Third, these data could identify factors useful in locating latrines and the presence of otters.

Spring is a particularly important time for river otters in the northern states due to parturition, breeding and dispersal. Adult females are under great physiological demands and physical restrictions, breeding soon after giving birth and nursing pups in the natal den until they are 8 to 10 weeks of age (Harris 1968, Melquist and Hornocker 1983, Woolington 1984). Yearling pups generally disperse at this time and adult males often range further to increase mating opportunities (Melquist and Hornocker 1983).

I monitored scat deposition and identified habitat characteristics at latrine sites in the Flathead River valley in northwestern Montana. Latrine sites were surveyed from April through June, 1987 to obtain information on relative use and habitat characteristics during spring.

STUDY AREA

The Flathead River valley in northwestern Montana has a Pacific Maritime climate influenced by the continental land mass and, in particular, the mountains of the Pacific Northwest (Delk 1972). The valley, north of Flathead Lake, lies at an elevation of 900 m. The Swan range to the east rises to 2300 m, the Whitefish range in the north to 2000 m, and western hills to about 1200 m.

Average summer temperatures range from 6° C in Kalispell on the northern boundary of the study area, to 8° C in Bigfork on the southern boundary. The mean January temperature in Kalispell is -6 C (Gaufin et al. 1976). The mean annual precipitation ranges from 38.5 cm in Kalispell to 55.7 cm in Bigfork. Approximately 1/2 of the annual precipitation falls during 5 months: November through January, May and June. During this study, the spring of 1987 exhibited drier and warmer weather than normal (Casey and Wood 1987). During colder winters, most of the waterways freeze, including the main stem of the Flathead, although small holes remain open, usually on spring-fed creeks and sloughs.

The study area in the Flathead River valley above Flathead Lake includes a variety of waterways (Fig. 1). The major river is the main stem of the Flathead, which drains 21,876 square km of southeast British Columbia and northwest Montana (Fraley and McMullin 1983). The North, Middle, and South Forks of the Flathead are the major tributaries upstream of the study area. Two smaller rivers; the Stillwater and the Whitefish, and four creeks; Ashley, Mill, Rose, and Swim, enter the Flathead River in the study area. Sloughs, ponds, and backwaters are common in mid-valley, forming an extensive system of waterways adjacent to the Flathead River. Downstream, the river channel becomes linear and more confined, except in the area of Fennon Slough and Rose and Swim Creeks.

The average gradient of the Flathead from the South Fork confluence to Flathead Lake is 53 cm/km (0.05%); river length is 73 km (Graham et al. 1981). Flows in the main River are influenced by Hungry Horse Dam on the lower South Fork of the Flathead. The unregulated North and Middle Forks are major contributors to high water in the main stem during late May through early June. Flows at this time approximate 560 m^3/sec with a high of 4,928 m^3/sec during the flood of 1964 (McMullin and Graham 1981, Bissell 1986). During the rest of the year, main stem flows are most influenced by the discharge from Hungry Horse Dam (constructed in 1953). The dam, used for hydroelectric generation and flood control, has a peak discharge

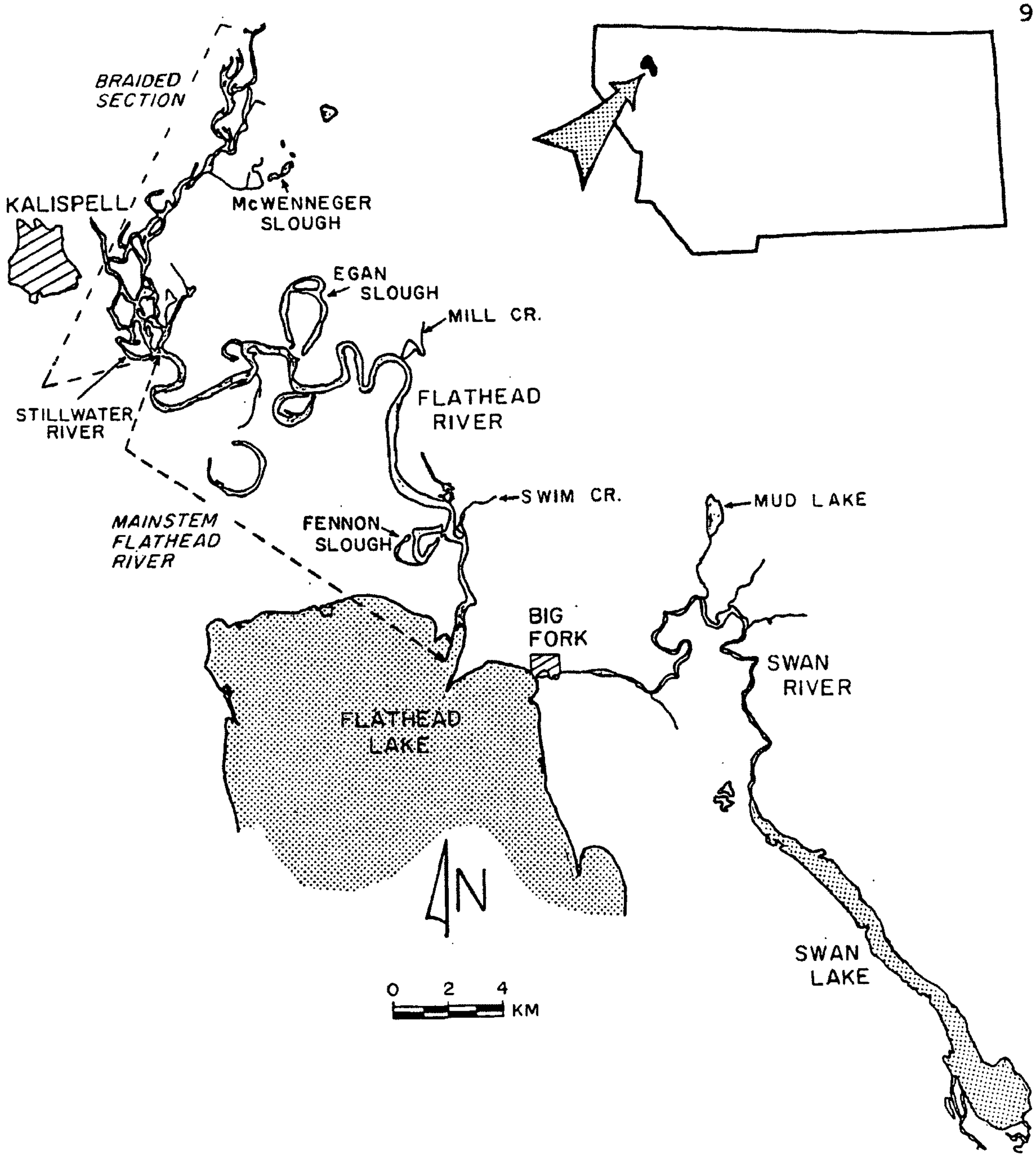

Fig. 1. Location of the study area in the Flathead River valley, northwestern Montana.

rate of 319 m^3/sec (Bissell 1986). Water levels in the study area in August have varied as much as 1.4 m/day (Fraley and McMullin 1983). The average discharge for the Flathead River, recorded at a USGS gauge approximately 10 km downstream from the confluence of the South Fork, has been about 270 m^3/sec from 1928 to 1980 (Graham et al. 1981). Winter flows can be less than 140 m^3/sec (McMullin and Graham 1981).

Kerr Dam on the southern end of Flathead Lake affects flows in the Lake and in the Flathead River as far up as the Stillwater River confluence. Throughout the year, the Lake level can fluctuate 3 m due to management of Kerr Dam for electrical power generation, recreation, and flood control. Abnormally high water in the Lake between July and September has caused a change in riparian communities on the lower River and Lake and may contribute to bank erosion. Minimum water levels occur in March and April.

Changing land use in the valley has had a major impact on the riparian vegetation community. Agriculture and timber users removed much of the native forest cover while livestock grazing decreased streambank vegetation (Bissell 1986). Currently, more than 68% of the land cover is classified as "undifferentiated, agricultural land" (Wright et al. 1982). Houses, roads, bridges, and recreation developments are encroaching on riparian areas. Between 1970 and 1980, the population in Flathead and Lake counties increased 32% (Wright et al. 1982). The expansion of urban areas is expected to have the greatest impact on riparian areas in the years to come.

Willows (<u>Salix</u> spp.) are common in the braided section and sloughs. Other shrubs include red-osier dogwood (<u>Cornus</u> <u>stolonifera</u>), hawthorne

(Cretaegus spp.), snowberry (Symphoricarpos albus), chokecherry (Prunus virginiana), wild rose (Rosa spp.), and water birch (Betula spp.). Some of these are more common as understory in the few remaining mixed conifer/deciduous forests. The dominant trees in the forests are spruce (Picea spp.) and black cottonwood (Populus trichocarpa). Douglas-fir (Pseudotsuga menziesii) and Ponderosa pine (Pinus ponderosa) have a more limited distribution. Cottonwood stands, including Populus angustifolia, are most common along river meanders and in the braided section of the study area. Emergent vegetation including sedges (Carex spp.), cattails (Typha latifolia), bullrush (Scirpus spp.), and horsetail (Equisetum arvense) is found in sloughs, ponds, along the north shore of Flathead Lake, and in the lower reaches of Flathead River.

A variety of fish species inhabit the study area. In the Flathead River, the major game fish are westslope cutthroat (Salmo clarki), bull trout (Salvelinus confluentus), and rainbow trout (Salmo gairderi) (Hanzel 1977). Kokanee salmon (Oncorhynchus nerka) were introduced into the Lake in 1916 and spawning runs of kokanee were documented in the Flathead River in the early 1930's. The size of the run in the main stem was largest from the 1950's to the mid-1970s but declined considerably in the late 1970's due to daily and seasonal water fluctuations caused by Hungry Horse Dam (Fraley and McMullin 1983). Less common game fish include brook trout (Salvelinus fontinalis), Yellowstone cutthroat trout (Salmo clarki bouvieri), lake trout (Salvelinus namaycush), Pygmy whitefish (Prospium coulteri), and mountain whitefish (Prospium williamsoni). Non-game fish in the main river are the northern squawfish (Ptychocheilus regonensis), slimy sculpin (Cottus cognatus), and largescale sucker (Catostomus macrocheilus) (Fraley and McMullin 1983). Other fish, which occur mainly in sloughs, are the Northern pike (Esox lucius), redside shiner (Richardsonius balteatus), largemouth bass (Micropterus salmoides), pumpkinseed (Lepomis gibbosus), yellow perch (Perca flavescens), and black bullhead (Ictalurus melas) (Graham et al. 1982 Supplement).

METHODS

River otter latrines were located through random and systematic surveys during this study and a previous furbearer survey (Bissell and Bown 1987). Additional latrines were discovered while radio-locating marked otters. Known, currently active latrines (n = 34) were sampled for habitat characteristics, changes in use, and to collect scats marked with radioisotopes for mark-recapture analysis during the time period of breeding, parturition, and lactation. Parturition occurs from approximately March through mid-May with most births in early April and weaning in early July in northwestern North America (Melquist and Dronkert 1987). Breeding follows soon after parturition.

Latrine Site Use:

Scats were recorded to obtain an index of latrine site use. Latrine sites were cleared of all scats in early April and surveyed every two weeks until 30 June 1987. New scats were collected for analysis of gross gamma ray count (Chapter II). Portions of scats were left to minimize disturbance. The following data were recorded at each latrine site: substrate, number of scats, other sign, and the maximum, minimum, and average distance from the latrine to the high water mark of the waterway.

Latrine Site Use Data Analysis:

I used a method developed by Zackheim (1982) to obtain an index of latrine site use that could be compared with Zackheim's data. Zackheim divided rivers into census sections of 9 to 17 km and established approximately 1 latrine plot/km. Latrine plots consisted of a 100 m segment of bank with 1 or, in rare cases, 2 or 3 latrine sites. A scat index for each census section was derived by dividing the total number of new scats by the number of latrine site days (latrines x days) since the last survey and multiplying by 100.

In my study area, census sections often contained dissimilar waterway categories (sloughs, main river, braided river). Analyses by section masked habitat use patterns within a section. Accordingly, I used 2 groupings to measure changes in latrine site use: 1) river section (Braided Flathead River/McWenneger Slough, Upper Flathead River/Egan Slough, Lower Flathead River/Fennon Slough), and 2) waterway category (main river, slough, and braided river). Grouping by waterway category illustrates changes in habitat use while grouping by sections may indicate relative changes in otter numbers and/or behaviors within a census section.

Changes in latrine site use were analyzed with 2 nonparametric statistical tests. I used Friedman 2 way analysis of variance to test the hypothesis that there was no systematic variation in the number of scats over time. Friedman 2 way anova was appropriate because it allows for repeated measures. The Wilcoxon signed rank test was used to test the hypothesis that there was no significant difference in the number of scats between one collection period and another. This test computed the sum of the ranked differences between the number of scats collected at $time_i$ and $time_j$ and two-tailed probabilities were reported. The tests were considered significant at $p \leq 0.02$ for the Wilcoxon signed rank due to the number of combinations and small sample sizes (D. Patterson, pers. commun.) and $p \leq 0.05$ for Friedman anova.

The relationship between the number of scats collected and the number of otters seen in a survey period for each census section was estimated using the coefficient of linear correlation (Ott 1984). The total number of otters seen was based on the maximum group size observed plus otters distinguished by size or markings as different from the otters seen in a group. Observations were subsequent to radio-locations and latrine surveys; they were infrequent and I was unable to test for accuracy. Hence, the number of otters is a minimum population estimate for the survey period. During some survey periods otters were known to be in the census section but were not actually seen. These data were deleted from correlation analysis because no otter counts were obtained.

Habitat Use:

In June, habitat variables were recorded for each latrine site and for each of 41 available sites. I allocated available sites proportionally by stratum (waterway category) area and randomly located them within strata. The following variables were recorded at all sites (Table 1): category of waterway (CAT), bank slope above the water line (SLOPE), bank slope below the water line (BANKS), water depth 1 m from shore (DEPTH), and the presence of den sites (DEN). The following variables were determined for an area 10 m up and down stream and 3 m

Table 1. Description of habitat variables for latrine site and available site analysis.

ACCESS accessibility of site to use by humans
- 1 - road or trail adjacent to site
- 2 - site separated from human use areas by 3 - 30 m of vegetation
- 3 - site separated from human use area by > 30 m of vegetation
- 4 - island site

BANKS bank slope below the current water level
- 1 - flat (emergent marsh)
- 2 - 10 - 84%
- 3 - 85 - 200%
- 4 - > 200%

CAT category of waterway
- 1 - valley river
- 2 - valley slough or pond
- 3 - valley braided section

CVR10 vegetation cover type 10 m up and downstream and 3 m inland

TREE	SHRUB	HERB
0 - none	0 - none	0 - none
1 - coniferous	1 - dense shrub	1 - marsh
2 - mixed	2 - shrub	2 - grass
3 - deciduous	3 - sparse shrub	3 - sedge

DEPTH measured in meters, 1 m from shore at site
- 1 - < 1 m
- 2 - 1 - 2 m
- 3 - > 2 m

DISTPA presence or absence of a disturbance factor within 10 m up and down stream and 3 m inland

DISTTYP type of disturbance factor
- 0 - none
- 1 - recreational use (i.e. fishing access)
- 2 - inhabited structure
- 3 - water pump, dam, or irrigation pipe
- 4 - grazing
- 5 - agriculture
- 6 - bridge or road

DGN distance to nearest Canada goose nest measured on map to nearest 100 m

DNC — distance to nearest confluence measured on map to nearest 100 m

DNL — distance to nearest active beaver lodge or cache measured on map to nearest 100 m

OBSTPA — presence or absence of a waterway obstruction for 10 m up and down stream and 3 m inland

OBSTTYP — type of waterway obstruction
- 0 - none
- 1 - beaver lodge or dam, or log jam
- 2 - logs
- 3 - brush

POOL — pools for 100 m up and down stream and across the waterway were visually estimated based on the presence of eddy lines and recorded as the percent waterway pooled
- 1 - 1-5%
- 2 - 6-25%
- 3 - 26-65%
- 4 - 66-95%
- 5 - 96-100%

SHORE — the configuration of the shoreline for 100 m up and downstream of the latrine site
- 1 - straight
- 2 - convex (out into the waterway)
- 3 - concave (inland from the waterway)

SLOPE — bank slope above the current water level
- 1 - flat (< 10%)
- 2 - 10-84%
- 3 - 85-200%
- 4 - ≥200%

VOVR — vegetation >3 m in height was determined by counting the number of points under the canopy at 1 m intervals for 20 m parallel to the waterway and 3 m inland and converted to percent
- 1 - 0-25%
- 2 - 26-50%
- 3 - 51-75
- 4 - 76-100%

VUDR — percent vegetation that would cover a river otter at the site when viewed from 3 m offshore
- 1 - 0-25%
- 2 - 26-50%
- 3 - 51-75%
- 4 - 76-100%

inland of the site: disturbance (DIST), access to the site (ACCESS), obstructions in the waterway (OBST), vegetation cover type (CVR10), and percent cover of overstory (OVER) and understory (UNDER) vegetation. I measured bank variables to 3 m inland because this included the average distance inland of latrines in this study (2.85 m). Shoreline configuration (SHORE) was recorded for 100 m up and down stream of the site. The percentage of pooled water (POOL) was visually estimated for an area 100 m up and down stream and across the width of the waterway. The location of active beaver (Castor canadensis) lodges and caches, and Canada goose (Branta canadensis) nests, were obtained from other studies in the area (G. Bissell and M. Wood, pers. commun.). Distance to nearest confluence (DNC), distance to nearest beaver lodge or cache (DNL), and distance to nearest goose nest (DGN) were measured to the nearest 100 m on USGS 7.5" quad maps. Further descriptions of each of these variables are given in Table 1.

Habitat Use Data Analysis:

To test the hypothesis that habitat characteristics of latrine sites occurred in proportion to their availability, the habitat data were pooled for all latrine sites and compared with pooled data for all random sites using a chi-square test of independence. The Bonferroni confidence intervals were used to determine preference or avoidance of individual habitat categories because this is not determined by the chi-square (Neu et al. 1974). Sample sizes fulfilled Roscoe and Byars (1971:759) guidelines for the chi-square statistic; for data with moderate departures from uniform an acceptable approximation at the 0.01 level will be achieved if the average of all categories of expected observations is greater than or equal to 6 and no expected category is < 1.

Correlation of ordinal habitat variables within the latrine site data set and the available site data set was investigated using Pearson and Spearman's rank order correlations. No 2 variables had correlation coefficients > 0.5 or < -0.5, hence no 2 variables were considered significantly correlated.

Discriminant function analysis has become a widely used method for wildlife habitat analysis (e.g. Williams 1983, Verner et al. 1984, Rominger and Oldemeyer 1989, Servheen and Lyon 1989). Although it is optimal to have a multivariate normal distribution for conducting discriminant function analysis, DFA can be used for exploratory analysis on data that are distributed other than optimally (D. Patterson, pers. commun.). Some researchers (Capen et al. 1984) suggest that categorical variables may be better analyzed using logistic regression but it is appropriate to use DFA when analyzing categorical variables as long as the variables are at least ordinal (D. Patterson, pers. commun). A discriminant function model was used to evaluate the ability of my habitat variables to separate latrine sites from the available sites. The original twelve ordinal variables were reduced in univariate F tests using the selection criteria of $p \leq 0.1$. A minimum of five observations for every variable is one general rule for data analysis (D. Patterson, pers. commun.), although ratios of 10:1 (Magnusson 1983) and 25:1 (Johnson 1981) have been suggested for DFA. The log of DNL and the log of DNC were also tested.

Discriminant analyses and chi-square tests of independence were carried out using the computer statistical package SYSTAT (1985). All statistical tests were considered significant at $p \leq 0.05$.

RESULTS

Latrine Site Use:

Scat numbers varied between latrines sites and survey periods (Table 2). The total number of scats was greatest on the first survey ($n = 100$) and decreased through the next 4 surveys (89, 80, 34, 34). However, changes over all survey periods were not significant (Friedman anova $p = 0.192$). Using the Wilcoxon signed rank test, changes in scat numbers between surveys 1 and 4, and 1 and 5, were each significant at $p \leq 0.02$.

When the data were divided into individual census sections (Braided River/McWenneger Slough, Upper River/Egan Slough, Lower River/Fennon Slough) the Friedman anova p values were 0.182, 0.067, 0.031, respectively. This suggests some pattern of change in scat numbers occurred over time in the latter 2 census sections but this was only significant for the Lower River/Fennon Slough section (Table 2). Total scat numbers in Lower River/Fennon Slough were highest during the first survey and dropped before rising by the final survey (48, 14, 0, 5, 16). Using the Wilcoxon signed rank test, differences between surveys 1 and 2, 1 and 3, and 1 and 4 were each significant at $p \leq 0.02$. Residents on Fennon Slough viewed a group of 4 otters in winter and early spring. After the first survey period this group was not seen. The Upper River/Egan Slough section exhibited a high of 53 scats on the second survey. This number differed from the number of scats collected during

Table 2. River otter scats collected at each latrine in a census section, northwestern Montana, April-June, 1987. Significance tests: * = Friedman anova p ≤ 0.05 for all surveys, *** = Wilcoxon signed rank p ≤ 0.02 for each survey vs. first survey.

		Median Survey Date (Julian Dates)							
Section	Lat.	122	137	151	166	180	Total	Mean	SD
McWenne-	1	0.0	0.0	1.0	0.0	0.0	1.0	0.2	0.5
ger Sl.	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
through	3	0.0	0.0	9.0	0.0	0.0	9.0	1.8	4.0
braided	4	1.0	0.0	1.0	1.0	2.0	5.0	1.0	0.7
section	5	1.0	0.0	1.0	2.0	5.0	9.0	1.8	1.9
Flathead	6	0.0	0.0	2.0	2.0	0.0	4.0	0.8	1.1
River	7	12.0	10.0	10.0	2.0	0.0	34.0	6.8	5.4
	8	2.0	0.0	3.0	0.0	0.0	5.0	1.0	1.4
	9	7.0	0.0	2.0	0.0	0.0	9.0	1.8	3.0
	10	3.0	0.0	12.0	0.0	1.0	16.0	3.2	5.1
	11	7.0	12.0	2.0	10.0	0.0	31.0	6.2	5.1
	Total	33.0	22.0	43.0	17.0	8.0	123.0		
	Mean	3.2	2.0	3.9	1.5	0.7			
	SD	4.0	4.5	4.3	2.9	1.6			
Upper	12	5.0	9.0	5.0	0.0	2.0	21.0	4.2	3.4
mainstem	13	0.0	0.0	2.0	0.0	0.0	2.0	0.4	0.9
Flathead	14	0.0	0.0	5.0	0.0	0.0	5.0	1.0	2.2
River to	15	4.0	8.0	18.0	6.0	7.0	43.0	8.6	5.5
Egan	16	10.0	28.0	1.0	4.0	0.0	43.0	8.6	11.5
Slough	17	0.0	8.0	6.0	2.0	1.0	17.0	3.4	3.4
	Total	19.0	53.0	37.0	12.0	10.0	131.0		
	Mean	3.2	8.8	6.2	2.0	1.7			
	SD	4.0	10.2	6.1	2.5	2.3			
Lower	18	0.0	0.0	0.0	2.0	8.0	10.0	2.0	3.5
mainstem	19	2.0	0.0	0.0	0.0	0.0	2.0	0.4	0.9
Flathead	20	10.0	0.0	0.0	0.0	0.0	10.0	2.0	4.5
River to	21	7.0	0.0	0.0	0.0	4.0	11.0	2.2	3.2
Fennon	22	8.0	1.0	0.0	3.0	0.0	4.0	2.4	3.4
Slough	23	3.0	0.0	0.0	0.0	4.0	7.0	1.4	2.0
	24	4.0	0.0	0.0	0.0	0.0	4.0	0.8	1.8
	25	14.0	13.0	0.0	0.0	0.0	27.0	5.4	7.4
	Total	48.0	14.0	0.0	5.0	16.0	75.0		
	Mean	6.0	1.8	0.0	0.6	2.0			
	SD	4.6	4.6	0.0	1.2	3.0			
	Sig.		***	***	***		*		
All	Total	100.0	89.0	80.0	34.0	34.0			
	Sig.				***	***			

surveys 1, 4, and 5 at $p < 0.07$. Survey 3 differed from survey 5 at $p = 0.028$. These differences failed to reach the significance level ($p \leq 0.02$) set for the Wilcoxon signed rank test. Paired differences in scat numbers in the Braided River/McWenneger Slough census section did not vary significantly using the Wilcoxon signed rank test.

When latrines were grouped by waterway category, scat deposition decreased significantly in sloughs throughout the survey periods (Friedman anova $p = 0.032$) (Table 3). Wilcoxon rank sum differences between survey periods 1 and 5 were significant at $p \leq 0.02$. Changes in scat numbers over survey periods in the braided and main river categories and at river/slough confluences were not significant. For the entire survey period the largest number of scats were collected from sloughs ($n = 186$). During the second survey, sloughs had the greatest number of scats of all waterway categories (71) while the braided section of river had no scats. Peak flows were recorded at this time (32,900 cfs at the confluence of the South Fork and main stem Flathead River at Columbia Falls).

Using Zackheim's non-statistical scat index technique the highest scat index (31.2) was recorded for the Upper River/Egan Slough section. Scat indices for the Braided River/McWenneger Slough section and the Lower River/Fennon Slough section were 15.6 and 14.8, respectively (Table 4). In waterway categories, the scat index technique showed use of latrines at sloughs and river/slough confluences was essentially equal; 29.5 and 30.5, respectively. The scat index for the main river was 12.0 and for the braided river was 6.8.

The correlation coefficient between the number of otters seen and the number of scats collected was $r = 0.89$, $p = 0.003$ for all survey

Table 3. River otter scats collected at each latrine by waterway category, northwestern Montana, April-June, 1987. Significance tests: * = Friedman anova p ≤ 0.05 for all surveys, *** = Wilcoxon signed rank p ≤ 0.02 for each survey vs. first survey.

		Median Survey Date (Julian Dates)							
Category	Lat.	122	137	151	166	180	Total	Mean	SD
Braided	1	0.0	0.0	1.0	0.0	0.0	1.0	0.2	0.5
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	9.0	0.0	0.0	9.0	1.8	4.0
	4	1.0	0.0	1.0	1.0	2.0	5.0	1.0	0.7
	5	1.0	0.0	1.0	2.0	5.0	9.0	1.8	1.9
	6	0.0	0.0	2.0	2.0	0.0	4.0	0.8	1.1
	Total	2.0	0.0	14.0	5.0	7.0	28.0		
	Mean	0.3	0.0	2.3	0.8	1.2			
	SD	0.5	0.0	3.3	1.0	2.0			
Slough	7	12.0	10.0	10.0	2.0	0.0	34.0	6.8	5.4
	8	2.0	0.0	3.0	0.0	0.0	5.0	1.0	1.4
	9	7.0	0.0	2.0	0.0	0.0	9.0	1.8	3.0
	10	3.0	0.0	12.0	0.0	1.0	16.0	3.2	5.1
	11	7.0	12.0	2.0	10.0	0.0	31.0	6.2	5.1
	16	10.0	28.0	1.0	4.0	0.0	43.0	8.6	11.5
	17	0.0	8.0	6.0	2.0	1.0	17.0	3.4	3.4
	24	4.0	0.0	0.0	0.0	0.0	4.0	0.8	1.8
	25	14.0	13.0	0.0	0.0	0.0	27.0	5.4	7.4
	Total	59.0	71.0	36.0	18.0	2.0	186.0		
	Mean	6.6	7.9	4.0	2.0	0.2			
	SD	4.7	9.4	4.4	3.3	0.4			
	Sig.					***	*		
River	12	5.0	9.0	5.0	0.0	2.0	21.0	4.2	3.4
	13	0.0	0.0	2.0	0.0	0.0	2.0	0.4	0.9
	14	0.0	0.0	5.0	0.0	0.0	5.0	1.0	2.2
	19	2.0	0.0	0.0	0.0	0.0	2.0	0.4	0.9
	20	10.0	0.0	0.0	0.0	0.0	10.0	2.0	4.5
	22	8.0	1.0	0.0	3.0	0.0	12.0	2.4	3.4
	23	3.0	0.0	0.0	0.0	4.0	7.0	1.4	2.0
	Total	28.0	10.0	12.0	3.0	6.0	59.0		
	Mean	4.0	1.4	1.7	0.4	0.9			
	SD	3.9	3.4	2.4	1.1	1.6			
River/	15	4.0	8.0	18.0	6.0	7.0	43.0	8.6	5.5
Slough	18	0.0	0.0	0.0	2.0	8.0	10.0	2.0	3.5
Confl.	21	7.0	0.0	0.0	0.0	4.0	11.0	2.2	3.2
	Total	11.0	8.0	18.0	8.0	19.0	64.0		
	Mean	3.7	2.7	6.0	2.7	6.3			
	SD	3.5	4.6	10.4	3.1	2.1			

Table 4. River otter latrine census sections and scat indices on the Flathead River, northwestern Montana, April - June, 1987. Calculations follow procedures of Zackheim (1982).

Section	Length (km)	No. of latrines	No. of surveys	New scats located	Latrine-site days	Scat index
McWenneger Sl. through Braided Section of Flathead River	12	11	5	123	788	15.6
Upper mainstem Flathead River to Egan Slough	7	6	5	131	420	31.2
Lower mainstem Flathead River and Fennon Sl.	9	8	5	83	560	14.8

periods and $r = 0.97$, $p = 0.035$ for the first 2 survey periods (Fig. 2). Only census sections and survey periods where otters were observed were included in the analysis.

Habitat Use:

Seven habitat variables differed significantly between otter latrine sites and available sites. Latrines occurred on concave shorelines with steep underwater banks and a high percentage of pooled water. Latrines were located in moderate to dense vegetation near waterway obstructions proportionally more often than available sites. They were also located closer to confluences and beaver lodges or caches than available sites.

Latrine sites did not occur on shoreline types in proportion to availability ($p \leq 0.05$); concave shorelines occurred more often and straight shorelines less often ($p \leq 0.05$) (Table 5). Banks with an underwater slope > 84% were used proportionally more than their occurrence ($p \leq 0.05$). Almost 50% of the latrine sites were located at cut or undercut banks while none occurred at flat banks (Table 6). Use of cut banks may be related to the occurrence of latrines near pools but POOL and BANKS showed only low linear correlation ($r = 0.425$, $p \leq 0.05$) and did not reach the r level of 0.5 or -0.5 to be considered significantly correlated. All latrine sites were adjacent to at least 5% pooled water and had a greater percentage of pools than available sites ($p \leq 0.05$) (Table 7).

Preferred sites for latrines were in the moderate to dense shrub type ($p \leq 0.05$) but no selection was seen for overstory vegetation (Table 8); over 50% of both latrine and available sites lacked forest cover

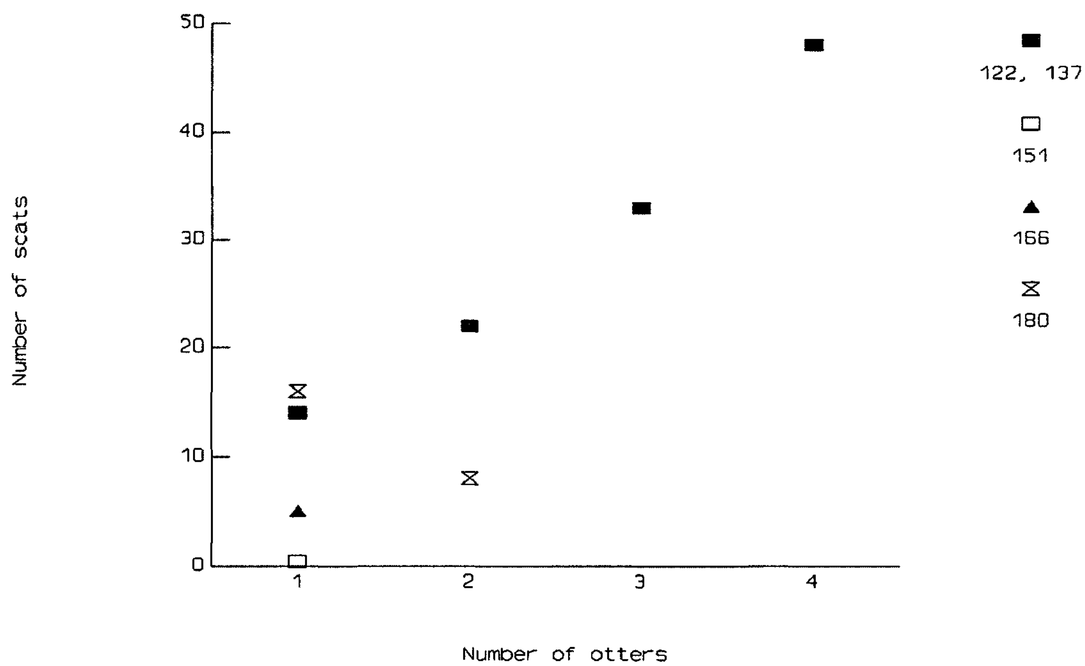

Fig 2. Number of scats collected correlated with the number of otters observed by census section for survey periods from April - June, 1987 in the Flathead River valley, northwestern Montana. Census sections where no otters were observed during a survey period are not included. Symbols refer to average Julian date of survey periods.

Table 5. Comparison of river otter latrine site use and availability by shoreline configuration in northwestern Montana. Use = latrine site use. $X^2 = 9.50$, df = 2, p = 0.009.

Shoreline	Avail. Sites	Prop. of Avail. Sites	Use Observed (O)	Use Expected (E)	Use Index (O/E)	Sig.[1]
straight	23	0.56	9	19	0.47	*
concave	11	0.27	21	9	2.33	*
convex	7	0.17	4	6	0.67	--

1/ Bonferroni Z tests differ significantly from available:
* = $p \leq 0.05$
** = $p \leq 0.01$

Table 6. Comparison of river otter latrine site use and availability by bank slope below the waterline in northwestern Montana. Use = latrine site use. $X^2 = 14.47$, df = 3, p = 0.002.

Bank Slope	Avail. Sites	Prop. of Avail. Sites	Use Observed (O)	Use Expected (E)	Use Index (O/E)	Sig.[1]
flat	8	0.19	0	7	0.0	**
10-84%	21	0.51	12	17	0.71	--
84-200%	6	0.15	6	5	1.20	--
> 200%	6	0.15	16	5	1.20	**

1/ Bonferroni Z tests differ significantly from available:
* = $p \leq 0.05$
** = $p \leq 0.01$

Table 7. Comparison of river otter latrine site use and availability by percent pools in the waterway, in northwestern Montana. Use = latrine site use. $X^2 = 17.67$, df = 3, p = 0.001.

Pools	Avail. Sites	Prop. of Avail. Sites	Use Observed (O)	Use Expected (E)	Use Index (O/E)	Sig.[1]
0-5%	15	0.37	0	12.5	0.0	**
5-15%	10	0.24	13	8.0	1.63	--
16-65%	2	0.05	7	2.0	3.50	--
66-100%	14	0.34	14	11.5	1.22	--

1/ Bonferroni Z tests differ significantly from available:
* = $p \leq 0.05$
** = $p \leq 0.01$

Table 8. Comparison of river otter latrine site use and availability by shrub category in northwestern Montana. Use = latrine site use. $X^2 = 10.3$, df = 2, p = 0.005.

Shrub Category	Avail. Sites	Prop. of Avail. Sites	Use Observed (O)	Use Expected (E)	Use Index (O/E)	Sig.[1]
none to sparse	26	0.63	9	21	0.43	**
moderate to dense	15	0.37	25	13	1.92	**

1/ Bonferroni Z tests differ significantly from available:
* = $p \leq 0.05$
** = $p \leq 0.01$

within 10 m. More than 90% of the latrine sites were located near a waterway obstruction, much more often than the availability of obstructions ($p \leq 0.05$) (Table 9). Log jams and beaver lodges were the most common obstructions at latrine sites.

Latrine sites were located closer to confluences than available sites (Table 10). Half of all latrine sites were within 100 m of a confluence compared to only 15% of random sites. Latrines were also located closer to beaver lodges and caches than available sites (Table 11).

Two habitat use variables differed from habitats available at $p < 0.1$ but did not meet the $p < 0.05$ criteria of significance: depth of the waterway adjacent to the site (DEPTH) and site accessibility (ACCESS) may also influence areas of latrine site use with greater depths and low site access preferred.

Discriminant Function Analysis:

A discriminant function model with 6 variables (DNL, BANKS, POOL, OBSTPA, DEPTH, ACCESS) had a classification rate of 79%; 85% of the latrine site cases and 73% of the available cases were correctly classified (Table 12). A 4 variable model (logDNL, BANKS, OBSTPA, DEPTH) correctly classified 79% latrine and 78% random sites for a total classification rate of 78.5% (Table 13). Average prediction rates for both models were similar to classification rates (Tables 12, 13). Standardized canonical discriminant function coefficients are reported in Table 14.

Table 9. Comparison of river otter latrine site use and availability by waterway obstruction category in northwestern Montana. Use = latrine site use. $X^2 = 8.96$, df = 1, p = 0.003.

Waterway Obst.	Avail. Sites	Prop. of Avail. Sites	Use Observed (O)	Use Expected (E)	Use Index (O/E)	Sig.[1]
absent	16	0.39	3	13	0.23	**
present	25	0.61	31	21	1.48	**

1/ Bonferroni Z tests differ significantly from available:
** = p ≤ 0.01

Table 10. Comparison of river otter latrine site use and availability by distance to nearest confluence (DNC) in northwestern Montana. Use = latrine site use. $X^2 = 34.20$, df = 3, p = 0.005.

DNC (meters)	Avail. Sites	Prop. of Avail. Sites	Use observed (O)	Use expected (E)	Use Index (O/E)	Sig.[1]
0-100	6	0.15	17	5	3.40	**
200-400	17	0.41	9	14	0.64	--
500-700	10	0.24	5	8	0.63	--
≥ 800	8	0.20	3	7	0.43	--

1/ Bonferroni Z tests differ significantly from available:
** = p ≤ 0.01

Table 11. Comparison of river otter latrine site use and availability by distance to nearest beaver lodge (DNL) in northwestern Montana. Use = latrine site use. $X^2 = 12.59$, df = 4, $p = 0.013$.

DNL (meters)	Avail. Sites	Prop. of Avail. Sites	Use Observed (O)	Use Expected (E)	Use Index (O/E)	Sig.[1]
0-100	4	0.10	14	3	4.67	**
200-300	13	0.32	7	11	0.64	--
400-500	8	0.19	8	7	1.14	--
600-900	9	0.22	3	7	0.43	--
≥ 1000	7	0.17	2	6	0.33	--

1/ Bonferroni Z tests differ significantly from available:
** = $p \leq 0.01$

Table 12. The number and percentage of river otter latrine sites and available sites correctly classified and predicted by the 6 variable discriminant function analysis model (DNL, BANKS, POOL, OBSTPA, DEPTH, ACCESS).

	Sites classified by the model: Used	(% corr.) (class.)	Avail.	(% corr.) (class.)	Total classified
Used sites (% corr.) (predicted)	29 (72.5)	(85.3)	5 (14.3)	(14.7)	34 (100.0)
Avail. sites (% corr.) (predicted)	11 (27.5)	(26.8)	30 (85.7)	(73.2)	41 (100.0)
Total predicted	40 (100.0)		35 (100.0)		75

Table 13. The number and percentage of river otter latrine sites and available sites correctly classified and predicted by the 4 variable discriminant function analysis model (logDNL, BANKS, OBSTPA, DEPTH).

	Sites classified by the model: Used	(% corr.) (class.)	Avail.	(% corr.) (class.)	Total classified
Used sites (% corr.) (predicted)	27 (75.0)	(79.4)	7 (17.9)	(20.6)	34 (100.0)
Avail. sites (% corr.) (predicted)	9 (25.0)	(22.0)	32 (82.1)	(78.0)	41 (100.0)
Total predicted	36 (100.0)		39 (100.0)		75

Table 14. Standardized canonical discriminant function coefficients and classification rates for habitat variables at river otter latrine sites versus available sites on the Flathead River, northwestern Montana, April - June, 1987.

Habitat variable	Latrine sites vs. available	Latrine sites vs. available
ACCESS	0.327	
BANKS	0.529	0.524
DEPTH	0.266	0.209
DNL	-0.321	
logDNL		-0.594
OBSTPA	0.534	0.466
POOL	0.062	
% Latrine Sites correctly classified	85.3	79.4
% Available Sites correctly classified	73.2	78.0
% Total Sites correctly classified	79.3	78.7

DISCUSSION

Latrine Site Use:

Otters exhibit variable and flexible behavior, including latrine site use. Although latrine sites may be traditional, many factors may influence time and degree of use. These include reproductive condition, social structure, prey base, weather, vegetation, water levels, and human disturbance as well as changes in otter densities (Melquist and Hornocker 1983, Foy 1984, Conroy and French 1987, H. Kruuk and J. Conroy, pers. commun.).

River otters are not strictly territorial but latrines may be used to mark ranges or key areas within a range. Otters in Colorado and Idaho had overlapping home ranges exhibiting defense or mutual avoidance only of personal space or activity centers (Melquist and Hornocker 1983, Dronkert and Grode 1984, Mack 1985). In Idaho, scat deposition and possible marking by anal sac secretions was highest at activity centers (areas with abundant prey and sufficient shelter where an otter was located at least 10% of the time in a season) and increased as more otters gathered in these areas (Melquist and Hornocker 1983).

In my study, reproduction, prey, dispersal, and water levels, as well as some territoriality around activity centers, may have influenced otter behavior or densities, causing variations in scat deposition. The significant decrease in scats from the first survey to the last may have been due primarily to changes in otter densities. This was most apparent on the Lower River/Fennon Slough census section, the only census section to show a significant decrease. Initially high scat numbers may be linked with breeding and the possible function of scats and anal sac secretions in communicating territory and reproductive status.

Increased scat deposition in spring has been noted by other researchers. A peak in the number of scats occurred between 2 and 28 May in Montana (Zackheim 1982) and in early spring in Texas (Foy 1984).

Evidence that this increase is linked to breeding and not just time of year is suggested from studies of Lutra lutra in Europe. Unlike L. canadensis which breeds primarily in spring, L. lutra breeds at various times throughout its range. In Sweden, breeding and increased numbers of scats occurred in winter (Erlinge 1967, 1968). In Scotland most scats were found in late winter and spring (Conroy and French 1987) and 85% of the births were between May and August (Kruuk et al. 1987). The time between the increase in scats and parturition approximates the gestation period of 63 days.

Seasonal breeding has been attributed to variations in prey availability. Lactation requires great energy expenditure (Widdowson 1981). In Scotland, prey biomass was 10 times greater in summer during lactation than during other seasons (Kruuk et al. 1987). Prey availability may be the ultimate influence on the reproductive strategy of L. canadensis whose pups are born and nursed when many prey species are spawning.

While marking associated with breeding may cause increased scat deposition, dispersal of juvenile otters may be a factor in the decline in scats. In Idaho, the majority of juveniles dispersed between 12 and 13 months of age (Melquist and Hornocker 1983). In my study area, 2 groups of 3 and 4 otters were sighted in early spring but only single otters (or females with new litters) were observed by June.

The significant decrease in the use of the slough waterway category was probably caused by increased otter movements due to emergence of pups from the natal den, dispersal, and changes in water levels.

In April and May, the majority of otter observations were from sloughs. Pups generally leave the natal den between 8 to 10 weeks of age and travel to rearing areas (Melquist and Hornocker 1983). Radio locations and sightings in mid to late June found 2 females with pups were moving away from the security of the natal den. After leaving the natal den, marked female 630 and her pups moved between sloughs, ponds, and the main river. This movement probably caused increases in the number of scats found in different waterway categories. Emergence of pups may also have influenced movements and dispersal of yearling otters into different waterway categories.

Variations in water levels probably influenced otter use of different waterways. No scats were recorded at latrines in the braided river during peak flows while sloughs, less impacted by flows, contained high numbers of scats. Maximum pool of Flathead Lake in mid-June resulted in high water levels as far upstream as the mouth of the Stillwater River. These water levels flooded both latrine and den sites in the main river and Fennon Slough.

Spring scat indices from census sections in this study were higher than those from southwest Montana (15.8 - 31.2 versus 4.4 - 18.9, respectively) (Zackheim 1982). My radio locations and observations showed no movement of marked otters between sections during the survey period, hence census sections had some relationship to actual otter home ranges. Because not all otters in the study area were instrumented or observed it is difficult to determine how the movements of unmarked animals affected changes in scat densities in these sections.

Most otter researchers caution against the use of scats to estimate otter numbers. Due to the many factors that influence scat deposition, Foy (1984:90) stated "the amount of sign will probably be of little value in determining otter densities unless used to compare relative usage of nearby habitat types at the same time of year".

In Scotland, a relationship between numbers of scats and otters was seen but only over large areas with sampling periods of close to a year and corrections for seasonality (Conroy and French 1987). In England, it was thought that changes in habitat use were probably more accurately tracked than changes in otter numbers (Jenkins and Burrows 1980).

Lutra lutra, in Scotland, often defecated in the water (H. Kruuk and J. Conroy, pers. commun.). This behavior has not been documented in North America but, in Idaho and Alaska, females with young generally did not defecate near the natal den site (Melquist and Hornocker 1983, Woolington 1984). Although avoidance of defecation by the natal den site may be common behavior, 6 scats were collected near 630's natal den. Behavior to disguise the location of the natal den may include defecation in water which could bias the use of scat numbers as an index of otter numbers.

Despite the various factors that may affect otter behavior and scat deposition, correlations of the number of individual otters observed in a census section with the number of scats collected from that survey period were very good. The correlation coefficient was less for the entire spring than for 2 survey periods (1 month) but were far better than other researchers have assumed (Melquist and Hornocker 1983, Foy 1984) or seen (Kruuk et al. 1986, Conroy and French, in prep).

It is apparent that scat deposition at latrines can be quite variable but correlations between scat and otter numbers may actually exist when examined over large census sections (3 - 10 km as in this study) for short (1 month) time periods. A concerted study using observations and scat collections should be conducted. Observation periods should be standardized, occurring near selected latrine sites which are then surveyed every 1 to 2 weeks. These same surveys may be used to determine changes in habitat use.

Habitat Use:

Habitat variables that distinguish river otter latrine sites from available sites were identified using the X^2 statistic and Discriminant Function Analysis. All 6 habitat variables in the most effective DF model (DNL, BANKS, POOL, POOL, OBST, DEPTH, ACCESS) were significant at $p < 0.1$ in the X^2 analysis. Vegetation cover type (CVR10) and shoreline configuration (SHORE) were nominal variables and not entered into the DFA. Although distance to nearest confluence (DNC) was a significant ($p = 0.005$) variable in the X^2 analysis, the addition of DNC to the Discriminant Function Analysis decreased the classification rate. Tests of significance do not always indicate a variable that will separate well (D. Patterson, pers. commun.).

The lower classification rate of available sites (73% as opposed to 85%) is probably due to some available sites exhibiting suitable characteristics for latrine sites. This is to be expected in a habitat that is not fully occupied or where animals exhibit strict territoriality.

Habitat characteristics at latrine sites appear to be influenced by energy and security needs. For Idaho otters, the greatest influence on habitat use appeared to be food (Melquist and Hornocker 1983). Selection for latrine sites on concave shoreline with steep underwater banks and near deeper waters with pools and obstructions may reflect better prey habitat as well as ease of access. The location of latrines in areas of beaver activity with a moderate to dense shrub type and moderately difficult access for humans increased otter cover and security.

Shoreline configuration differed significantly between latrine sites and available sites in the X^2 analysis. Use of concave shorelines with steep underwater banks for latrine sites may be due to the availability of food and cover in these areas. The preference of coastal otters in Alaska for convex shorelines with steep slopes and short intertidal lengths was believed to be due to the presence of preferred prey species, a shorter distance from water to vegetative cover, and a greater amount of natural cavities for den sites (Larsen 1983, Woolington 1984). A steep underwater bank allows an otter to swim directly up to the latrine site. The lack of latrines along shorelines with underwater slopes < 10% may be due to the shallowness of the water for swimming. In Scotland, otter use of latrines next to underwater banks > 60 degrees was attributed to prey and cover availability (Veen 1986).

Use of latrine sites adjacent to pools may be influenced by the hydraulic properties of an eddy (which allows an otter to more easily leave the current) or by an increased prey base in pools. Research conducted previously in the study area found perch (Perca flavescens) and

Mountain whitefish (Prospium williamsoni) in 46.8 and 31.0% of river otter scats, respectively (Bissell and Bown 1987). Perch are most often found in pools and slow moving water. Foraging otters may spend more time in these areas, resulting in more defecations, and/or they may defecate for territorial reasons. Scent marking by scats, urine, and, possibly, anal sac secretions is believed important in otter communication at activity centers (Melquist and Hornocker 1983).

More than 90% of the latrines were located within 10 m of an obstruction. Obstructions, particularly log jams, provide foraging areas, cover, and den sites. Otters do not make their own dens and the availability of dens and resting sites is an important aspect of river otter habitat (Larsen 1983, Melquist and Hornocker 1983, Anderson and Woolf 1984). Obstructions provide cover for prey species and logjams in Idaho provided excellent foraging sites (Melquist and Hornocker 1983).

The use of more dense shrub cover types is similar to studies elsewhere (Jenkins and Burrows 1980, Melquist and Dronkert 1987). Otters in Idaho avoided lakes and reservoirs with little or no cover (Melquist and Hornocker 1983).

The location of latrines near confluences may reflect greater use of areas with more than one waterway. Latrines may indicate an activity center or a common intersection. In Europe, territorial activity, consisting of scent marking and defecating, increased at sites common to several individuals (Erlinge 1968). Location of otter sign may be facilitated by searching within 100 m of confluences.

Latrines occur near beaver lodges and caches because otters and beavers use similar habitat and otters use beaver lodges for latrine and den sites. Beaver activity increases pools and cover and a number of state agencies have noted increases in otter populations with the expansion of beaver populations (Bottoroff et al. 1976, Lehman 1979, Anderson and Woolf 1984, Berg and Kuehn 1984). In a study in Arkansas, 17% of the latrines were on beaver lodges or bank dens (Karnes and Tumlison 1984). In my study area, 2 latrines were on beaver lodges and 10 were within a few meters, while more may have been near undetermined beaver bank dens. Beaver lodges and bank dens constituted 38% of the otter resting sites in Idaho (Melquist and Hornocker 1983).

The amount of human activity that otters will tolerate varies widely and appears related to habitat quality and quantity (Melquist and Hornocker 1983). Riparian areas in the study area were used for farming, ranching, and recreation and otters used latrine sites that were "moderately difficult" to access.

CONCLUSIONS

I attempted to determine variables that may help in locating latrine sites for monitoring purposes or for identifying aspects of suitable otter habitat. The 6 variable Discriminant Function model adequately separated latrine sites from random in the study area. The 4 variable model was almost as reliable. The 79 - 85% correct classification of latrine sites indicates these variables may aid in locating river otter latrine sites in the Flathead River Valley. Whether these variables are applicable throughout Montana and the western states requires further testing. A number of studies (Verner et al. 1984) caution against extrapolating predictive models developed from local studies to larger areas.

Variables that can be measured from maps would minimize the time and effort required to identify suitable latrine site areas. A DFA model using logDNL, logDNC, OBSTRUC, ACCESS (all obtainable from maps and aerial photos) had an overall classification rate of 72%. A DFA model of these variables may be appropriate for preliminary investigations.

To improve the likelihood of discovering otter sign, while minimizing time and effort, I recommend searches of 100 m up and downstream of a confluence and 3 m inland. Spring surveys may have the highest probability of success if conducted concurrent with snow melt but before high water. Scat concentrations may be highest at this time and scats deposited during winter will be easily detectable before spring vegetation growth. If more than just presence/absence data is required, I suggest a single clearance of each site with a resurvey 1 to 2 weeks later as an index of otter use.

Kruuk et al. (1986) cautioned against the use of scats for monitoring purposes because they failed to find a correlation between otter activity in an area and scat numbers. Data from my study indicate that a correlation may exist and merits further study. Still, it is important to consider that scat deposition may be affected by densities, season, reproductive condition, and individual and group behavior.

Many latrines sites may be traditional - most of the sites I surveyed were located 2 years previously (Bissell and Bown 1987) and were still being used 1 year after the completion of my field work. It seems both appropriate and prudent to monitor latrines in order to determine trends in otter populations over time and to continue to refine models which aid our understanding of those habitat components associated with latrine sites.

Techniques for determining the status of otter populations have relied on indices of density based on tracks, scats, scent posts, trapping reports, harvest records, and observations (Zackheim 1982, Humphrey and Zinn 1982, MacDonald and Mason 1982). Many researchers recommend a combination of methods. The results reported here should facilitate our understanding of otter latrine site use and habitat.

CHAPTER II

RADIOISOTOPES IN SLOW-RELEASE POLYLACTIC ACID IMPLANTS AS A MARKING TECHNIQUE TO ESTIMATE POPULATION SIZE IN RIVER OTTERS.

INTRODUCTION

Population size of river otters (Lutra canadensis) in the Flathead River valley between Kalispell and Flathead Lake was studied from April to July 1987. A mark-recapture technique was used. This study was designed to evaluate the use of implantable radioisotope tablets as a marker of river otter scats and to obtain a population estimate to be used in a model of harvest effects on the otter population.

Knowledge of the size of a population can be an important component in species management. Mark-recapture techniques, used to determine population size, present problems when used with secretive, wide-ranging mammals. These species are often difficult to capture and mark. Recapture can be difficult and time-consuming with biases imposed by trap-prone or trap-shy animals. Radioisotopes are marks that do not require the recapture or further observation of the study animal. The animal is marked with small doses of radioisotopes that can be detected in collected scats. Marked scats constitute the recapture. This technique allows a large sample size to be collected in a short time. The primary assumption is the ratio of marked to unmarked scats is proportional to the ratio of marked to unmarked otters (Pelton and Marcum 1977).

Radioisotope tracers were originally used to follow animal movements (Godfrey 1954, Miller 1957). They have been used infrequently in mark-recapture studies since the late 1960's (Pelton and Marcum 1977). Animals marked using this technique include rabbits (Sylvilagus spp.) (Nellis et al. 1968), various rodents (Gentry et al. 1971, Tamarin et al. 1983), bobcats (Felis rufus) (Nellis et al. 1968, Labisky and Conner 1982), foxes (Vulpes spp.) (Nellis et al. 1968), black bear (Ursus americanus) (Pelton and Marcum 1977), coyotes (Canis latrans) (Davison 1980, Crabtree 1989), European badgers (Meles meles) (Kruuk et al. 1980), river otters (Knaus et al. 1983, Shirley et al. 1988), and raccoons (Procyon lotor) (Conner and Labisky 1985).

Numerous radioisotopes are used as biological tracers, but only a few have the necessary characteristics for a mark-recapture study. Small doses of radioisotopes are used to minimize health risks to the animal, investigator, and public. Gamma emitters are advised, as lower energy beta rays are difficult to detect in the scats (M. Pelton, pers. commun.). The physical half-life must be sufficient for detection throughout the length of the study. The biological half-life should be neither too short or too long for effective and safe marking. A long half-life can make detection difficult due to reduced excretion rates and will also expose the animal to radioactivity over a longer period of time. A short half-life may eliminate the isotope too rapidly. The feces should constitute the primary mode of excretion. Insignificant amounts of zinc-65 (^{65}Zn) and manganese-54 (^{54}Mn) were found to be excreted in the urine (Nellis et al. 1968). ^{65}Zn with a physical half life of 245 days and a biological half-life of 930 days is preferred for mark-recapture studies.

The radioisotope is usually placed in the animal by injection into the bloodstream (Pelton and Marcum 1977, Davison 1980, Kruuk et al. 1980, Shirley et al. 1988). In carnivores, doses range from 10 microcuries (μCi) (Labisky and Conner 1982) to 100 μCi (Kruuk et al. 1980) or from less than 1 μCi per kilogram of body weight (Pelton and Marcum 1977) to 8 μCi/kg (Kruuk et al. 1980).

Radioisotope marking by injection creates some concerns. It causes an initial burst of radioactivity and rapid excretion (Pelton and Marcum 1977, Labisky and Conner 1982, R. Crabtree, pers. commun.). The safety of this initial burst of radioactivity to the animal is unknown. The liquid injection method results in the loss of over 95% of the radioactivity in the first 50 days (R. Crabtree, pers. commun.). Injection can contaminate the researcher through drops of liquid solution and improper care of the syringe.

Development of an implantable polylactic acid (PLA) tablet impregnated with a radioisotope solved a number of these problems. Designed by R. Crabtree and F. G. Burton (University of Idaho, Moscow, and Battelle, Pacific Northwest Laboratories, Richland, Washington), the tablets dissolve slowly with a minor initial burst and relatively constant release rates thereafter (Crabtree et al. 1989). Isotopes with shorter half-lives can be used in smaller doses in tablet form (10 - 20 μCi) than by the injection method (20 - 100 μCi) (R. Crabtree, pers. commun.). Tablets are safer to transport and handle than liquid-based radioisotopes. PLA is a biodegradable polymer that breaks down into lactic acid (Crabtree et al. 1989).

A sufficient number of animals must be marked and an adequate number of feces collected for reliable statistical analysis. The number of animals marked in a study has varied from 2 (Kruuk et al. 1980) to 48

(Conner and Labisky 1985). The number of scats collected in a single sampling period ranged from 19 to 49 with coyotes (Davison 1980), 0 to 43 for black bear (Pelton and Marcum 1977), and 22 to 71 for raccoons (Connor and Labisky 1985). Eighty feces were required for an accurate estimation of a badger population (Kruuk et al. 1980).

Multiple collection periods increase the precision of the statistical analysis. The combination of slow release tablets with radioisotope physical half-lives of nearly a year allows a number of scat collections over 1 year (R. Crabtree, pers. commun.). Optimal sampling schemes have not been determined and a variety have been used. Conner and Labisky (1985) suggested a minimum of 5 collections separated by 2 week intervals. Ideally, scat collection periods should be structured to minimize the effects of population change resulting from reproduction or dispersal.

Mark-recapture studies require several assumptions: populations are discrete or time spent in the study area by individual animals can be quantified, animals will not lose marks during the study, all marks are correctly identified, and each animal has a constant and equal probability of capture during each trapping session (Otis et al. 1978:9). The use of radioisotopes as a marker assumes unmarked scats are not contaminated by marked scats, no loss of marks, and scat collections are random and unbiased. The equal recapture assumption for scats is difficult to assess but independence of the otter trapping and scat recapture phases helps to reduce bias. Connor and Labisky (1985:330) note Seber (1982) in saying: "heterogeneity of capture does not bias estimates of abundance if the sources of heterogeneity in the marking and recapturing phases are independent". Loss of marked animals and time spent by a marked otter in the study area can be determined through radiotelemetry (Kruuk et al. 1980, Shirley et al. 1988, R. Crabtree, pers. commun.). Scats can be traced to an individual animal by the use of different isotopes and radio telemetry. Whether animals defecate at similar rates can be investigated by marking animals with different isotopes and determining time spent in the study area.

Population estimates have been derived in other radioisotope mark-recapture studies using the Lincoln Index or the Schnabel method (Schnabel 1938, Pelton and Marcum 1977, Davison 1980, Conner 1982). An alternate equation is being developed by Robert Crabtree and statisticians from the University of Idaho, Moscow, Idaho (R. Crabtree, pers. commun.).

Although no deleterious effects are expected from small tracer doses, few long term studies have been conducted with large samples of animals. Knaus et al. (1983) injected a captive male and female otter with 48 and 23 μCi of ^{65}Zn, respectively. Total radiation doses absorbed over 215 days were < 13 rads for the male and < 7 rads for the female (less than a normal chest x-ray). By the end of the otter's life these amounts would increase by 3%. The lower dose was sufficient as radioactivity was detectable in the scats for the entire study. A 10 μCi dose of ^{65}Zn is 0.74% of the annual limit on intake for humans, set by the International Commission on Radiological Protection (Connor and Labisky 1982).

Researchers concurred that radiation levels used should not be detrimental to the otter or it's offspring (pers. commun. from: R. Crabtree, W. VanMeter, M. Pelton, G. Linscombe, K. Foresman). Still, the use of radioisotopes remains limited in the wildlife field due to questions of public and animal health and safety (Nellis et al. 1967, Connor and Labisky 1985, K. Foresman, pers. commun.).

STUDY AREA

The original study area extended from McWenneger Slough, northeast of Kalispell, down the Flathead River to the confluence with Flathead Lake. Radio-locations of marked otters indicated that the Swan River (from Swan Lake downstream to the confluence with Flathead Lake) and associated creeks and ponds were also used; as a result, this area was added to the study area (Fig 1). Refer to Chapter 1 for a complete description of the study area.

METHODS

River otters were live-trapped along the Flathead River between Kalispell and Flathead Lake during the fall of 1986. Modified Hancock live-traps (Melquist and Hornocker 1979) and modified #11 Victor double longspring leghold traps (Shirley et al. 1983) were used. A veterinarian implanted radio transmitters following the procedures of Melquist and Hornocker (1979). Radioisotope marking followed techniques developed by R. Crabtree (Fig. 2). Markers were 15 - 20 μCiof ^{65}Zn, ^{54}Mn, or ^{57}Co in polylactic acid tablets. These radioisotopes have physical half-lives of 245 to 312 days and biological half-lives of 17 to 930 days (Pelton and Marcum 1977). Each otter was implanted with a different marker or

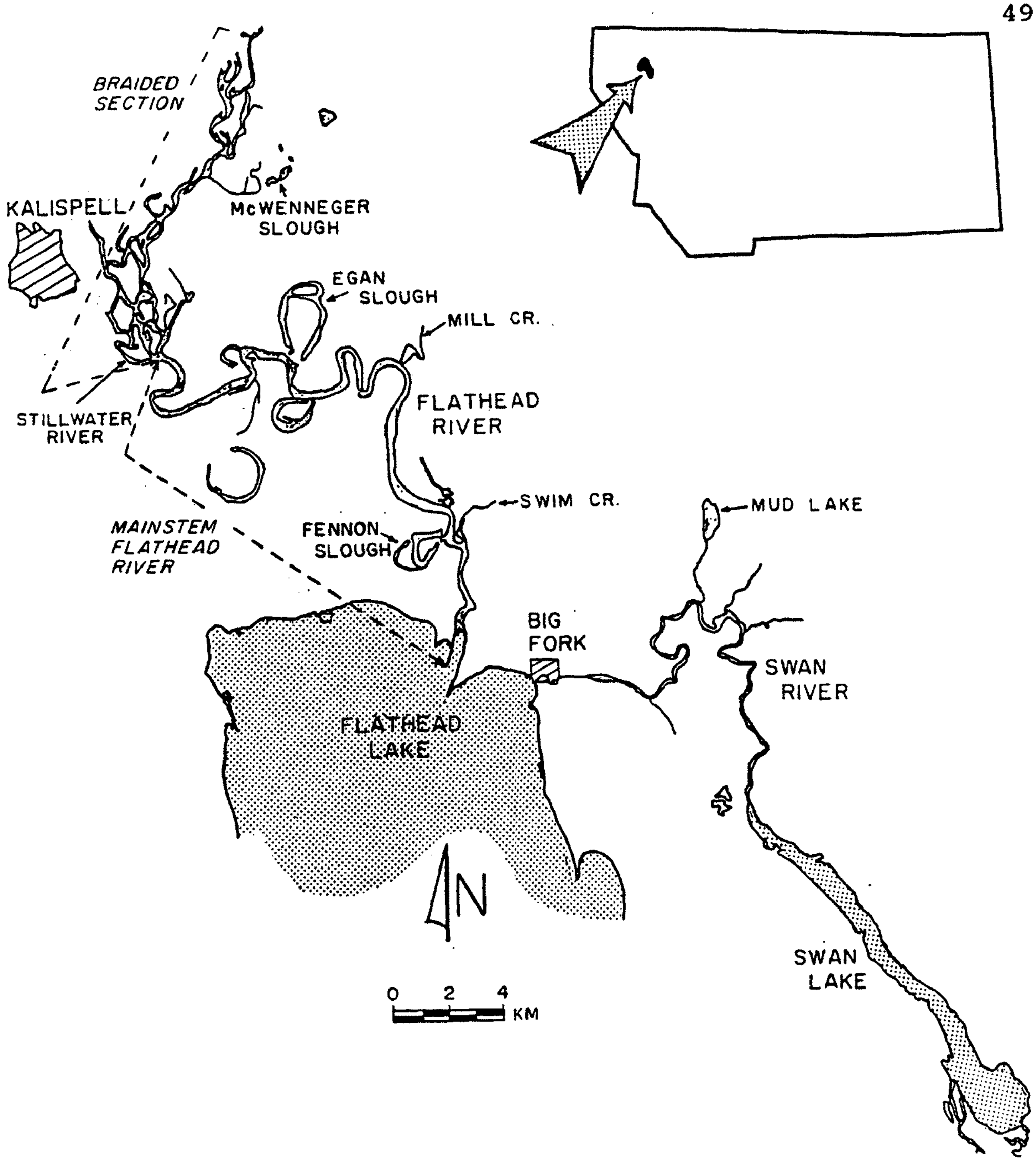

Fig. 1. The location of the study area in the Flathead and Swan River valleys, northwestern Montana.

Fig. 2. Procedures for the use of radioisotope implants. Guidelines established August 28, 1986 by Robert L. Crabtree, Battelle, Pacific Northwest Laboratories, Richland, Washington.

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1) Store implants in glass vials inside lead container. Store petri dish and rubber-tipped tweezers, for use during surgery, in ziplock storage bag. These materials will be held inside radiation labeled foot locker at University of Montana's Flathead Biological Station, East Shore, Montana.

2) Establish a temporary radiation zone prior to working with the radioisotope implant. Cover surgical area with radiation safety paper. Place implant, lead container, tweezers, petri dish, and waste container inside radiation zone.

3) Wear lab coat, shoe covers, 2 layers of surgical gloves, safety glasses, and face mask while performing surgery. Maximize distance from implant and minimize duration of surgery. A monitor person stands by with a Geiger-Mueller meter.

4) Place animal inside radiation zone. Make a subcutaneous incision slightly larger than the implant, tape hair back, wipe excess blood clear. Use a dowel to make a pocket for the implant under the skin incision. Take implant in glass vial from lead container. Remove implant from vial with rubber-tipped tweezers. Wipe implant on chemwipe in petri dish and place inside pocket under animal's skin. Wipe tweezers, monitor for radiation, and return to storage bag. Push implant into pocket using dowel. Dispose of dowel and chemwipe in radiation waste container. Monitor vial for contamination and return to lead container. Wipe incision clean and dispose of chemwipe. Suture incision quickly but carefully, wipe incision and dispose of needle and chemwipe in waste container. Place topical antibiotic on wound and spray with liquid bandage. Monitor checks surgeon's gloves for contamination. If contaminated, outer gloves are changed before moving animal from surgical area to transport container. Dispose paper covering surgical area in radiation waste container. Monitor checks for contamination before surgeon leaves temporary radiation zone. Gloves, shoe covers, and mask are placed in waste container and lab coat stored in plastic bag. Return all equipment to proper storage area.

5) Release animal after recovery form anesthesia.

6) Collect scats using rubber gloves and store in separate, clean, moisture resistant containers.

combination of markers, to identify each individual's scats. Ideally, markers should be placed as far as possible from sensitive body organs such as the liver and kidney but the thickness of the otter's pelt made a neck implant difficult. The tablets were therefore implanted subcutaneously in the area of the radiotransmitter incision.

Scats were collected in February 1987, within a stratified random sample of 1/8 of the 238 km of waterway in the study area. Few scats (n = 19) were collected using this sampling scheme. In early April, all known latrine sites were cleared of old scats and 5 scat collections separated by 2 week intervals occurred between April and June. Scats were placed in separate plastic bags and frozen. Scats were air dried before analysis.

Analysis of each individual scat for gross gamma ray count was conducted at Batelle, Pacific Northwest Laboratories, Richland, Washington. All scats were initially analyzed using a multi-channel peak height analyzer with a germanium-drifted lithium detector. The emitted energies were displayed on an oscilloscope and computer printouts were studied to identify the radioisotopemark (1115 MeV = ^{65}Zn, 835 MeV = ^{54}Mn, 080 MeV = ^{57}Co). The germanium detector has low efficiency but very good resolution (R. Crabtree, pers. commun., L. Caldwell, pers. commun.). When no detectable amounts of radioactivity were discovered, a auto-gamma scintillation spectrometer containing a sodium iodide crystal (rather poor resolution but high efficiency) was used to investigate 50 scats collected from areas where known marked otters occurred. This method failed to detect gamma radiation. Finally, ashing of the scats and liquid scintillation were used.

RESULTS

Four otters were marked in fall 1986. One marked otter was killed by a trapper in mid-December. This otter, M740, was implanted in the back of the neck with a 15 μCi tablet of ^{65}Zn on October 31. M740 was necropsied on 3 January and a Geiger-Mueller meter was used to record radioactivity levels. Highest amounts of radioactivity were found in the liver and testes; when the meter was placed within 1 cm of these organs readings were 0.1 to 0.3 mr/hr. Radioactivity had dispersed throughout the body as blood and the head region showed radioactivity levels 0.05 to 0.08 mr/hr (2 to 3 times background in northwestern Montana).

The first scat collections occurred from 12 to 15 February 1987. Nineteen scats were collected from 4 sites. In spring, 371 scats were collected during 5 recapture periods from 37 latrine sites (Table 1).

Three different detection methods (multi-channel peak height analyzer with a germanium-drifted lithium detector, auto-gamma scintillation spectrometer with sodium iodide crystal, and liquid scintillation) failed to find significant amounts of radioactivity in any of the collected scats. A few printouts indicated possible activity in the marker energies, but they were not considered significant enough for use.

DISCUSSION

Radioisotope marks were not discovered for a number of possible reasons. Problems may have occurred at any of three levels: the quantity

Table 1: Number of river otter scats collected for analysis of radioisotope marks, Flathead and Swan Rivers, northwestern Montana. Survey dates reported in Julian dates.

Sampling Scheme	MEDIAN SURVEY DATE						Total
	44	122	137	151	166	180	
Systematic random	19						19
All known latrines		112	100	81	39	39	371
							390

of radioisotope and its decay schedule, the subcutaneous PLA implant delivery system, and the make-up and durability of the scat.

The use of the PLA implants is fairly new and, in the case of radioisotope impregnated tablets, relatively untested. The developer may have been too optimistic about the length of time these implants could effectively mark an animal's scats, estimated at 2 and possibly 3 years (R. Crabtree, pers. commun.). There are a number of factors which may affect the delivery of substances by the PLA implant tablets. First, release is into subcutaneous tissueand subsequent entry into the bloodstream may be affected by the local blood supply, subcutaneous fat, and activity (Blackshear 1979). In some cases, the body encapsulates the implant with fibrous tissue which may slow entry of the impregnated material into the circulation (Blackshear 1979).

Tablets were designed to contain 15 - 20 μCi of radioisotope but I was unable to verify this or the time of production. Radioisotope doses may have been lower or radioactive decay could have been further along than believed. R. Crabtree (pers. commun.) estimated radiation released in the process of implanting the animal would be between 0.5 and 5.0 millirems per hour (mr/hr) depending on the radionuclide. The tablets were giving off varying amounts of radioactivity when checked on 4 November, 1986: ^{57}Co = 2.7 mr/hr, ^{65}Zn = 2.5 mr/hr, ^{54}Mn = 0.7 mr/hr). These amounts are within the range suggested. Implants in coyotes marked scats for well over 1 year (R. Crabtree, pers. commun.). All scats in this study were collected and analysed within 285 days of implantation.

A PLA implant dose of 20 μCi of ^{65}Zn seems reasonable when compared with the amounts injected into animals in other studies. Twenty-three microcuries adequately marked otters in Louisiana for a minimum of 215 days (Knaus et al. 1983), although 55 μCi was used in a population study (Shirley et al. 1988). A penned bear injected with 50 μCi each of ^{65}Zn and ^{54}Mn passed scats with detectable isotopes for at least 1 year (Pelton and Marcum 1977). Twenty microcuries may be too low a dose when using ^{54}Mn and $_{57}$Co which have a relatively short biological half-life (17 and 10 days, respectively). In bear scats, ^{54}Mn remained detectable for 1 year although its activity declined more rapidly than that of ^{65}Zn, while ^{60}Co was undetectable in bear scat 24 days after injection of 60 μCi (Pelton and Marcum 1977). Adult coyotes were successfully marked with 15 μCi of ^{65}Zn (Davison 1980). Labisky and Conner (1982) used 1 μCi/kg of ^{65}Zn to mark a bobcat but suggested doses > 1 μCi/kg would be better. The average otter weight in this study was 8 kg resulting in a dose > 2 μCi/kg.

Up to 70% of an animal's scat may be composed of E. coli and other fauna (R. Crabtree, pers. commun.). The majority of the mark may be bound up in this matter, which is easily washed away from the scales and bones in an otter's scat. Still, Nellis et al. (1968) found that ^{65}Zn marked scats were quite resistant to weathering, and the marker could not be removed by aqueous extraction.

Some researchers believe the amount of ^{65}Zn excreted by an animal may be affected by dietary intake of zinc. Labisky and Conner (1982) hypothesized that erratic excretion rates in bobcat were due to changes in the animal's diet. It appeared that as dietary zinc decreased, fecal ^{65}Zn declined. Dr. D. Cataldo (pers. commun.), a chemist at Battelle Labs, believes dietary zinc intake would need to be incredibly high before it contributed to ^{65}Zn excretion.

Canids are the only other animals in which the PLA radioactive implants have been used. In the scats of free-ranging coyotes, radioactivity was detectable for well over 1 year (R. Crabtree, pers. commun.). Greater and more accurate calibration of the method with live laboratory animals appears necessary (D. Cataldo, pers. commun.). In particular, tablet disintegration may be a function of how a body walls it off. Three to six months of release can be expected without walling off; this may be considerably longer if the body does wall off the tablet (R. Crabtree, pers. commun). Encystation could conceivably halt release (D. Cataldo, pers. commun.). Perhaps the significant subcutaneous fat layer of the river otter caused just such an occurrence.

River otter scats can probably be marked with polylactic implants impregnated with radioisotopes, but larger doses and earlier scat collections are required than originally indicated. Problems and concerns with the use of radioisotopes have not been entirely eliminated with this technique. Even with doses of up to 100 μCi, current knowledge of the effects of radiation states the public health effects are miniscule, if any (R. Crabtree, pers. commun.). But the effects of radiation exposure are cumulative and saying there is no measurable danger does not solve the moral or emotional issue.

Most otter location techniques, such as sign monitoring and scat collections, give a relative estimate of density. Initial attraction of otters to scent posts in Florida (Humphrey and Zinn 1982) was later found to be inconsistent (Robson and Zinn 1985). Some researchers believe individual otters can be identified by tracking in snow (Erlinge 1968). When estimating numbers of wide-ranging and low density animals, reasonable precision may only be obtained with intensive sampling. Radioisotope marking may be an accurate, timely method for determining animal population size but the benefits must be weighed with public opinion and the ability to insure safe and conscientious use of radioactivity - no matter how small the dose.

Radioisotopes impregnated in slow release polylactic acid tablets may offer improved safety over liquid bases but further research is needed on encystation of implants, minimum dosages, and loss of the mark from scats.

CHAPTER III

HABITAT CHARACTERISTICS OF AREAS USED BY RIVER OTTERS DURING SPRING IN NORTHWESTERN MONTANA

INTRODUCTION

Effective habitat conservation demands predictive models of species habitat requirements. Our modern concepts rest on Hutchinson's (1958) definition of niche as a multidimensional phase/space wherein each habitat component constitutes a separate dimension. To this can be added Lyon's (1985:2) view of habitat selection as the "continuous search for that combination of habitat components best able to satisfy daily requirements".

Otters are found in a variety of aquatic habitats illustrating their adaptability if certain requirements are fulfilled (Melquist and Dronkert 1987). Otters are found from coastal estuaries (Foy 1984) to mountain stream headwaters (Melquist and Hornocker 1983) but undisturbed and abundant waterways, vegetation, and forage fish populations increase the duration and intensity of habitat use (Tabor and Toweill 1982, Melquist and Hornocker 1983). Home range sizes and dispersal distances are lower in food-rich coastal marshes allowing greater otter densities per unit area (Foy 1984, Shirley et al. 1988). Deep pools, sloughs, and good water quality are favorable factors (Mowbray et al. 1979, Melquist and Hornocker 1983, Foy 1984). Food availability probably has the greatest influence on habitat use (Melquist and Hornocker 1983, Mack 1985).

Den sites such as beaver lodges, rock piles, log jams, bank burrows, and tree roots are important (Melquist and Hornocker 1983, Anderson and Woolf 1984). Otter habitat is associated with the activities of beaver (Choromanski and Fritzell 1982, Reid 1984, Anderson and Woolf 1984, Mack 1985, W. Berg pers. comm.). Reid (1984) suggested that otters in N. Alberta actively breach beaver dams in winter, reducing the water level in ponds for easier foraging. Otters use beaver lodges and burrows for dens, sometimes when beavers are in residence (C. Mack pers. comm., K. Longsdon pers. comm.).

Otters appear to adapt well to the harsh conditions of winter (Melquist and Hornocker 1983, Mack 1985). Prey may be more accessible while snow provides additional cover. In an ice-covered lake, a radio-implanted male was not detected above ground for over 3 months (Reid 1984).

Habitat requirements may become vital at times of high energy demands. Female otters have increased nutritional requirements during gestation, lactation, and breeding: Mack (1985) estimated a 48% increase in net daily energy costs during this time. Females breed soon after giving birth (otters exhibit delayed implantation) and the aggressive courtship may continue over several days (Park 1971). An average 2 to 3 pups remain dependent until weaning at about 3 months of age (Liers 1951, Harris 1968). Because breeding females are under significant physiological and physical constraints, managers would be wise to give greater consideration to their habitat requirements. Stream and vegetative characteristics, as well as prey, may all be important to reproductive success.

The objective of this study was to investigate habitat components used by otters during the key season of gestation, lactation, and breeding and to identify those variables that, in combination, best define otter habitat during this time.

STUDY AREA

The original study area extended from McWenneger Slough, northeast of Kalispell, down the Flathead River to the confluence with Flathead Lake. Radio-locations of marked otters indicated that the Swan River (from Swan Lake downstream to the confluence with Flathead Lake) and associated creeks and ponds were also used; as a result, this area was added to the study area (Fig 1). Please refer to Chapter 1 for a complete description of the study area.

METHODS

Otters were captured on the Flathead River between Flathead Lake and Kalispell, Montana, using modified Hancock livetraps (Melquist and Hornocker 1979) and modified #1.1 Victor double longspring leghold traps (Shirley et al. 1983). Hancocks were painted with a flat, brown latex and soaked, in a stream, for a minimum of 3 days. Legholds were waxed, dyed, and stored in a clean bucket. Hancocks were set into the bank and stream bottom, and covered with mud and vegetation. Legholds were bedded and covered with vegetation and loose dirt on land, and sand and mud in the water. Human scent was minimized by wearing rubber gloves and waders and, when possible, by checking traps from a boat. Feathers and mink scent

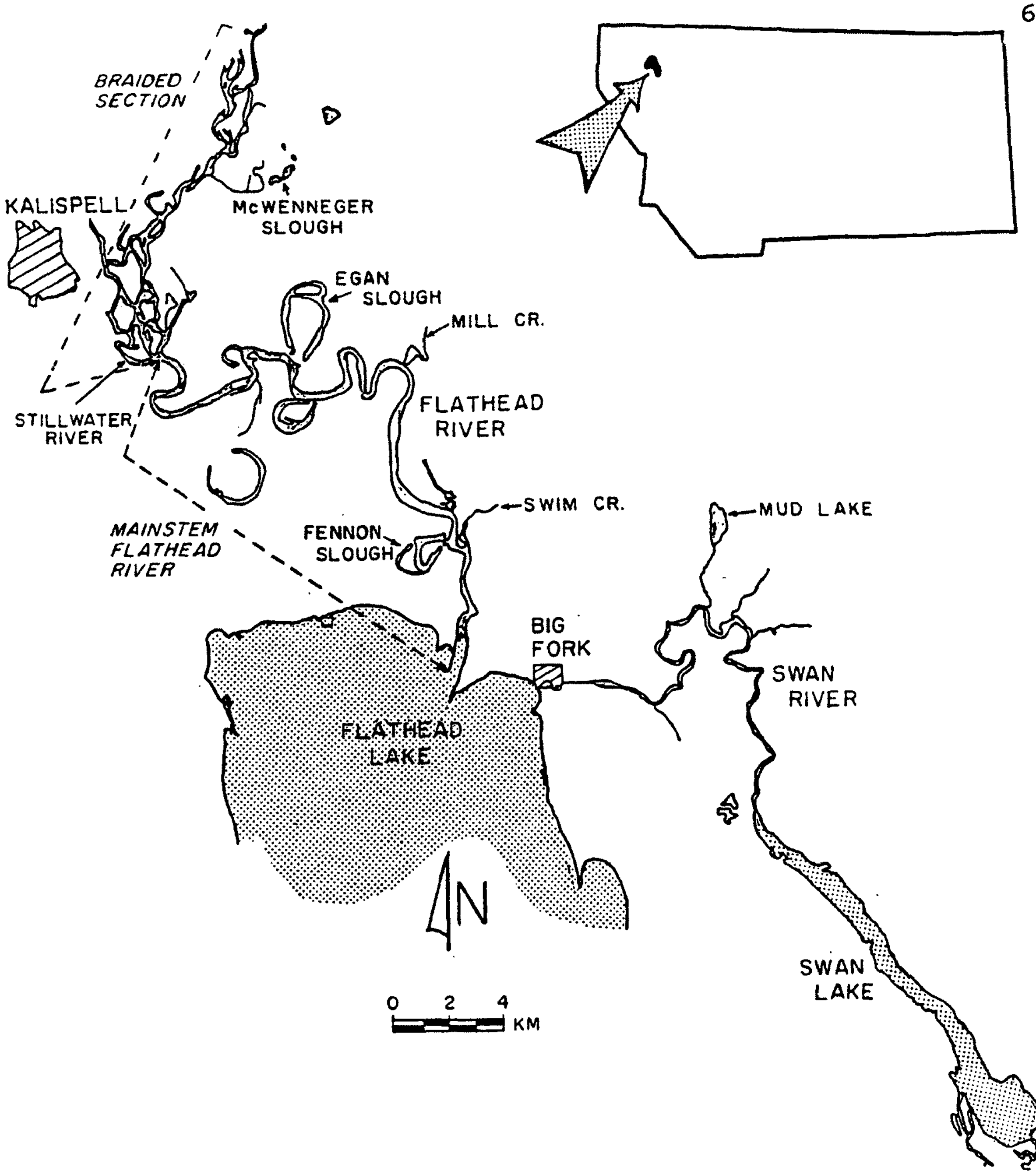

Fig. 1. The location of the study area in the Flathead and Swan River valleys, northwestern Montana.

glands were used as lures.

Four otters were trapped with legholds (212 trap nights/capture) and 1 otter was captured in a Hancock (99 trap nights/capture). In addition, 5 trappers were offered $200.00 for a live otter in good condition but no otters were obtained from this arrangement. Trapping commenced 1 September and extended to 8 November 1986, when freezing temperatures and heavy snowfall forced an end to humane livetrapping.

Otters were removed from leghold traps with a specially designed dip net (Shirley et al. 1983) and shield, or by guiding them into a den box with a sliding door (Mack 1985). They were transported to holding pens in the den box.

Otters were transferred to a squeeze box and anesthetized with an intramuscular injection of ketamine hydrochloride mixed with 2% acepromazine (20 mg/kg) and robinol (5 mg/kg) (Melquist and Hornocker 1979). They were weighed, measured, and eartagged, and sex was recorded (Appendix A). Age was estimated by tooth wear, body size, condition, and reproductive status (Melquist and Hornocker 1983, C. Mack, pers. commun.). Radio transmitters were implanted into the abdominal cavity by a veterinarian following procedures developed by Melquist and Hornocker (1983). Transmitters (Telonics Telemetry - Electronic Consultants, model IMP/400/L) measured 9.5 x 3.3 cm and weighed 85 - 90 g. A pulse rate of 36 per minute resulted in a transmitter life of up to 24 months. Transmitter range averaged 1 km. Radioisotope marker tablets were implanted subcutaneously in order to identify marked animal's scats with radioactivity detectors (R. Crabtree, pers. commun.). Otters were injected with a general antibiotic prior to release, usually the day following surgery.

Ranges, activity, and habitat use were monitored with a Telonics TS1 scanner/programmer and TS2 receiver (164 mHz) and various antennas. The 24 hour day was divided into 4, 6-hour periods. The same 6 hour period was monitored for 7 days and in this time a minimum of 2 locations, separated by 24 hours, were obtained for each otter. Only 1 location was recorded for every 6 hour period. This weekly schedule was used throughout the year long study. Locations were made from a fixed-wing aircraft, boat, truck, and on foot. All locations were plotted on USGS 7.5 Minute Series (topographic) maps and recorded using Universal Transverse Mercator (UTM) grid coordinates.

Home Range and Activity:

Home range length (HRL) was determined by measuring the length of the waterway (Melquist and Hornocker 1983, Mack 1985) between the 2 most distant points visited twice by an otter. Single visits outside these boundaries were considered exploratory and not part of HRL (Melquist and Hornocker 1983). HRL was reported for all locations of each instrumented otter during the entire study (September - June) and for spring (April - June).

Otters were classified as active or inactive based on signal consistency over a 5 minute period (Mack 1985). Movement in water caused attenuation of the radio signal pulses. If the animal was inactive, the den or resting site was located. If active, visual observation was used to record location and activity type. If the visual attempt caused the activity signal to alter, the observation was terminated (Melquist and

Hornocker 1983, Mack 1985). Activity was recorded only once per location.

Habitat Use:

Lyons (1985:2) suggested that, rather than determining each habitat variable in isolation from the rest, habitat availability should be looked at as a complex within which animals substitute different components to meet their needs and "includes all those components readily available within a short distance of the recorded location". He recommended increasing the sample area for each radio location to include an area around the sampling point. In the case of elk (Cervus elaphus), a 100-150 acre circle was "a reasonable estimate of the area occupied by an animal during a single day" (Lyon 1985:2).

Melquist and Hornocker (1983) suggested that an otter's range consisted of activity centers where life requirements were met and between which otters traveled to secure these needs. Movement data from otters in this study and other areas (Melquist and Hornocker 1983) indicated a 1 km square was an average "daily movement area" (DMA) when an otter was not traveling, and this area was used in habitat analysis.

Habitat use was determined from radiolocations recorded no more than once for each otter in each waterway type per day. Each radiolocation was plotted on a USGS 7.5' quad map and a 1 km square UTM grid measure was centered on it. This became the DMA in which habitat variables were determined. Available habitat was delineated by combining the home ranges of otters monitored in 1987. The available habitat was divided into 100 m blocks, each was assigned a number, and 71 blocks were selected using a stratified, random selection by waterway category. The same 1 km square was centered in each of these blocks in order to compare DMA with "available areas" (AA).

Each DMA and AA was sampled for habitat characteristics using plots, aerial photos, maps, and general reconnaissance (Table 1). In each square kilometer, the following variables were recorded along the waterway in 5 random plots (20 m long and 3 m wide), and the values averaged: cover types (CVRTYP) in trees, shrubs, and herbaceous vegetation; percent cover in overstory (VOVR); percent cover in understory (includes shrubs and herbs) (VUDR) (Johnson and Pelton 1980). The presence of pools was defined by eddy lines, and the percentage of the waterway pooled was visually estimated for 100 m up and downstream and across the width (POOL). The presence of beaver activity (BVR), in the form of lodges, bank dens, or caches, was obtained from data collected by G. Bissell (Montana Dept. of Fish, Wildlife, and Parks, pers. commun.) and from extensive ground surveys of the study area. The number of confluences (NOCON), obstructions (OBST), and disturbances (DIST) were obtained from aerial photos and ground truthing. Shoreline length (SHORE) was determined by centering a 1 km square UTM grid on the DMA or AA location and counting the number of 100 m squares that a shoreline fell into. Although USGS maps were not completely accurate, the use of a measurement wheel on aerial photographs and general ground comparisons showed the inaccuracy in actual shoreline was about equal throughout the study area.

Habitat characteristics of spring DMA and AA was compared using the chi-square test of independence. Each otter's use of its home range was evaluated separately by chi-square analysis. The criteria of Roscoe & Byars (1971) were used: no less than an average of 6 observations per cell

Table 1. Description of habitat variables recorded for otter daily movement areas (DMA) and available areas (AA).

BVR — type of beaver activity
- 0 - none
- 1 - tracks
- 2 - cuttings
- 3 - slide/trail
- 4 - lodge
- 5 - bank den
- 6 - dam
- 7 - scent mound
- 8 - abundant sign
- 9 - undetermined

CAT — category of waterway
- 1 - valley river
- 2 - valley slough
- 3 - creek or braided section of river
- 4 - pond or lake
- 5 - tributary river

CVRTYP — cover type in tree, shrub, herbaceous layers

TREE	SHRUB	HERB
0 - none	0 - none	0 - none
1 - coniferous	1 - dense shrub	1 - marsh
2 - mixed	2 - shrub	2 - grass
3 - deciduous	3 - sparse shrub	3 - Equisetum

DIST — number of disturbance factors
- 1 - no or 1 disturbance factor
- 2 - 2 or more disturbance factors

DISTAMT — amount of area disturbance affects
- 1 - low = $< 1/8$ of shoreline length
- 2 - moderate = 1/8 - 1/4 of shoreline length
- 3 - high = $> 1/4$ of shoreline length

DISTTYP — type of disturbance factors
- 0 - none
- 1 - recreational use (i.e. fishing access)
- 2 - inhabited structure
- 3 - water pump, dam, or irrigation pipe
- 4 - grazing
- 5 - agriculture
- 6 - bridge or road

NOCON — the number of confluences within the 1 km square were counted

OBST — presence or absence of obstructions
- 0 - none
- 1 - ≥ 1

OBSTTYP type of obstruction
- 0 - none
- 1 - beaver lodge or dam, logs or log jam
- 2 - rocks
- 3 - dock, dam, jetty or other unnatural
- 4 - brush
- 5 - emergent marsh vegetation

POOL the percent pools within the waterway for 100 m up and downstream, and across the waterway was visually estimated based on the presence of eddy lines
- 0 - none
- 1 - 1-25%
- 2 - 26-50%
- 3 - 51-75%
- 4 - 76-100%

SHORE shoreline length was determined by centering a 1 km square UTM grid on the location and counting the number of 100 m squares that a section of shoreline passed through

VOVR vegetation > 3 m in height was determined by counting the number of points under the canopy at 1 m intervals for 20 m parallel to the waterway and 3 m inland and converting to percent
- 1 - 0-25%
- 2 - 26-50%
- 3 - 51-75%
- 4 - 76-100%

VUDR percent vegetation that would cover a river otter at the site when viewed from 3 m offshore
- 1 = 0-25%
- 2 = 26-50%
- 3 = 51-75%
- 4 = 76-100%

and no cells with an expected value of less than 1. Bonferroni confidence intervals (Marcum and Loftsgaarden 1980) were used to determine preference or avoidance of individual habitat categories. Relative preferences were expressed by a preference index (use observed/use expected). If the same individual habitat categories were preferred by all otters (preference index greater than 1.00) then the data were pooled. Due to individual differences in otter use of habitat categories, most data were not pooled. Results were considered significant at $p \leq 0.1$.

I measured habitat availability for each otter within that otter's home range during 1987. This method was used to investigate third order selection (Johnson 1980): the use of habitat components within each animal's home range. The terms selection, preference, and avoidance are often used inconsistently (Thomas and Taylor 1990). In this study, these terms are not intended to signify active choice by an otter. "Use" of a habitat component is the quantity utilized by an otter without reference to availability of that component. "Preference" for a habitat component is shown by use measured in proportion to that component's relative availability.

Discriminant Function Analysis:

I used the multivariate statistical technique, discriminant function analysis (DFA) as a preliminary test (Williams 1983) to identify patterns of river otter spring habitat use that may suggest hypotheses for further study. Discriminant function analysis is composed of 2 steps: separation and classification. DFA is often used as a predictive model to distinguish between categories (such as used and unused habitat or species a, b, and c). In the case of linear discriminant analysis, a line is selected that best separates the groups. DFA maximizes the Mahalanobis distance (a measure of the distance between 2 population means). The model can then be used to classify observations into categories. DFA is increasingly used in the analysis of wildlife habitat data.

DFA was conducted using ordinal and interval variables. Prior to this, Spearman's rank and Pearson's correlations were run. If any 2 variables correlated at $r > 0.5$ or $r < -0.5$, 1 of the 2 was eliminated, retaining the variable most easily and accurately measured.

Stepwise discriminant function analysis using SPSSX (Nie 1983) and discriminant analysis using SYSTAT (Systat Inc. 1985) created similar models with nearly equal classification rates (≤ 1%), although Systat Inc. (1985) cautioned against the use of stepwise DFA. Only DFA analyzed with the software SYSTAT is reported.

RESULTS

Five river otters (2 males, 3 females) were trapped between 15 September and 8 November. All otters were implanted with radio transmitters and 4 were marked with radioisotopes. Otters were released at the trap site the day following surgery. A female died 2 weeks after release. A necropsy, performed by Montana State University pathology department, attributed death to starvation from adhesions of the renal capsule and mesentery of the intestine to the radiotelemetry implant incision site. This is the first recorded incidence in a river otter of death due to adhesions from surgery although a similar condition occurred in an radio-implanted beaver (Guynn et al. 1987). A male otter was killed by a trapper in mid-December. The surviving 3 otters were tracked until the end of the study.

Home Range:

A total of 214 radio locations were obtained from 5 otters between 15 September 1986 and 28 June 1987 (Table 2). Home range lengths (HRL) during the entire study varied from 15 km for F610 to 58 km for M709. Spring HRL of yearling female F610 was 4 km while lactating female F630 had a range of 11 km and adult male M709 ranged over 31 km. The small number of otters resulted in high home range variances. Averages are reported only for general comparison with other studies. Mean HRL for all otters during the study was 29 km (S.D. = 17.4 km). Mean HRL during spring (parturition, lactation, breeding) season was 15 km (S.D. = 14.0 km).

The number of radio locations needed to determine total and spring HRL was investigated graphically (Figs. 2,3). In spring, 10 radio locations per otter defined 90% of M709's HRL (100% defined by 31 locations), 82% of F630's HRL (100% defined by 50 locations), and 93% of F610's HRL (100% defined by 39 locations).

Habitat Use:

Ninety-nine radiolocations, obtained during the spring reproductive season from 3 otters, were used to define the center of 99 "daily movement areas" (DMA). Seventy-one random points established the center of 71 "available areas" (AA).

Table 2. Spring season and total home range length (HRL) of instrumented river otters in northwestern Montana based on length (km) of shoreline. Age classes: Y = yearling, A = adult.

Otter	Sex	Class	Spring Length	Spring Locations	Total Length	Total Locations
610	F	Y	4.0	39	15.0	78
630	F	A	11.0	50	31.0	73
879	F	A	--	--[1]	18.0	8[2]
709	M	A	31.0	24	58.0	41
739	M	A	--	--[1]	22.0	14[3]

1\ No locations obtained in spring
2\ 9/23/86 - 10/7/86
3\ 10/31/86 - 12/15/86

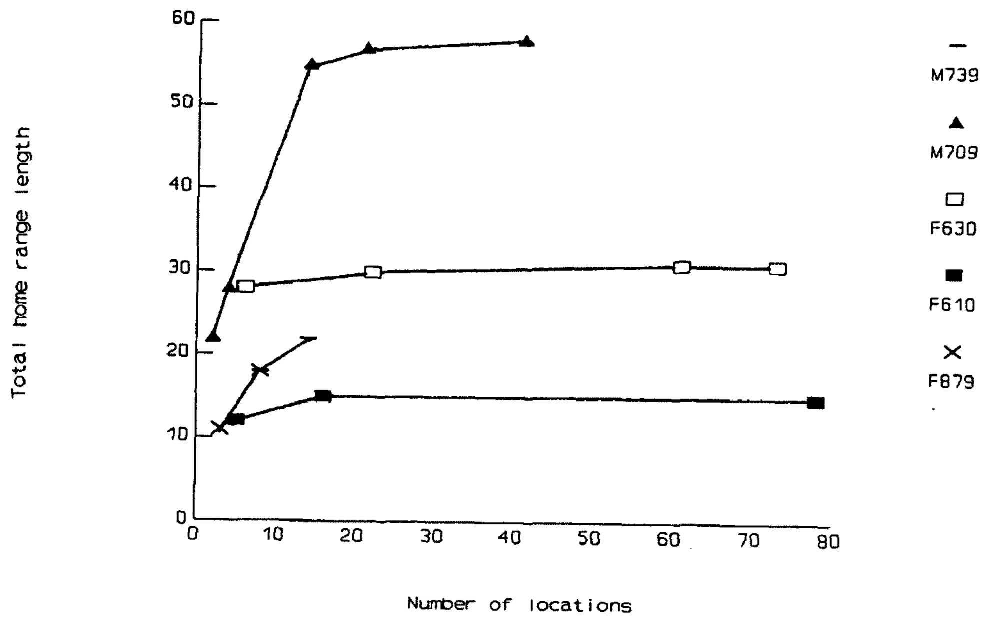

Fig. 2. Increases in total river otter home range length with greater numbers of radio locations in northwestern Montana.

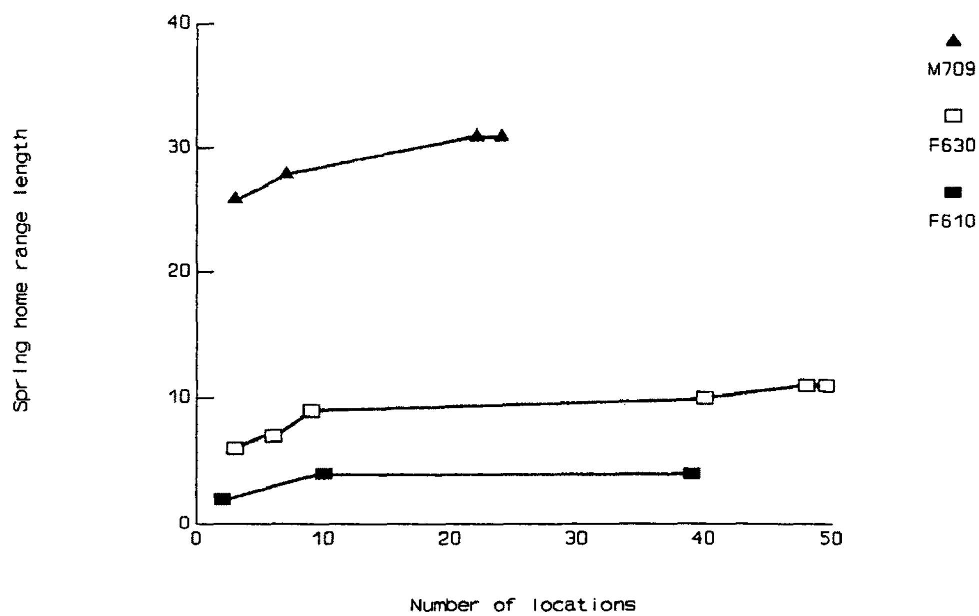

Fig 3. Increases in spring river otter home range length with increasing numbers of radio locations in northwestern Montana.

In spring, all instrumented river otter locations were in waterways in the Flathead or Swan River valleys. Using chi-square analysis, the following variables were determinedto be used other than in proportion to their availability ($p \leq 0.2$) by all individual otters in their ranges: waterway obstructions, understory cover, and shoreline (Tables 3,4,5). Shoreline length was the only variable that was highly significant ($p \leq 0.01$) for each otter (Table 5). Preference indices (Tables 3,4,5) further showed that each

otter preferred or avoided the same categories of the habitat variables (waterway obstructions, understory cover, shoreline, and disturbances) but Bonferroni Z scores were not significant for all otters (Tables 3,4,5,6).

Chi-square analysis of combined otter locations showed the above habitat variables were used significantly other than in proportion to their availability ($p \leq 0.001$) and Bonferroni Z scores were significant ($p < 0.05$) (Table 7).

Otters preferred areas with waterway obstructions; 95% of the otter locations but only 72% of the available locations occurred in areas with obstructions. Emergent marsh was the most common waterway obstruction followed by logs/log jams, 42% and 37% of the otter locations, respectively. Otters avoided areas that had low (≤ 25%) understory cover; 25% of the otter locations were in this understory category compared with more than 50% of the available locations. Combined otter DMA contained significantly greater shoreline lengths than available areas; 90% had medium or high shoreline categories. Areas with 1 or no disturbances were used in greater proportion than available. The most common disturbance factors in otter daily movement areas were bridges and roads (64%),

Table 3. Comparison of individual river otter habitat use and availability by waterway obstructions during spring in northwestern Montana. F610: $X^2 = 1.57$, df = 1, p = 0.21. F630: $X^2 = 5.21$, df = 1, p = 0.022. M709: $X^2 = 9.44$, df = 1, p = 0.002.

Otter	Waterway obst.	Avail. areas	Proportion available areas	Use observed (O)	Use expected (E)	Use index (O/E)	Sig.[1]
F610	absent	1	0.05	0	2	0.00	--
	present	21	0.95	34	32	1.06	--
F630	absent	7	0.30	4	14	0.29	*
	present	16	0.70	41	32	1.28	*
M709	absent	12	0.46	1	9	0.11	***
	present	14	0.54	19	11	1.73	***

1\ Bonferroni Z tests differ significantly from available:
* = p < 0.1
** = p < 0.05
*** = p < 0.01

Table 4. Comparison of individual river otter habitat use and availability by understory category during spring in northwestern Montana. F610: $X^2 = 26.34$, df = 3, $p < 0.001$. M630: $X^2 = 4.48$, df = 3, $p = 0.2$. M709: $X^2 = 5.00$, df = 3, $p = 0.172$.

Otter	Understory (%)	Avail. areas	Proportion available areas	Use observed (O)	Use expected (E)	Use index (O/E)	Sig. [1]
F610	≤25	3	0.14	0	5	0.00	--
	26-50	10	0.45	0	15	0.00	***
	51-75	5	0.23	22	8	2.75	***
	76-100	4	0.18	12	6	2.00	--
F630	≤25	4	0.17	4	8	0.50	--
	26-50	6	0.26	9	12	0.75	--
	51-75	13	0.57	27	23	1.17	--
	76-100	0	0.04	5	2	2.50	--
M709	≤25	5	0.19	0	4	0.00	**
	26-50	10	0.38	12	8	1.50	--
	51-75	6	0.23	4	5	0.80	--
	76-100	5	0.19	4	4	1.00	--

1\ Bonferroni Z tests differ significantly from available:
* = $p < 0.1$
** = $p < 0.05$
*** = $p < 0.01$

Table 5. Comparison of individual river otter habitat use and availability by shoreline distance during spring in northwestern Montana. F610: $X^2 = 12.00$, df = 2, $p < 0.002$. F630: $X^2 = 0.79$, df = 2, $p = 0.001$. M709: $X^2 = 9.3$, df = 2, $p = 0.01$. Shoreline distances are low = 1100-2400 m, medium = 2500-3000 m, high = > 3000 m.

Otter	Shore line	Avail. areas	Proportion available areas	Use observed (O)	Use expected (E)	Use index (O/E)	Sig.[1]
F610	low	8	0.36	4	12	0.33	--
	med	4	0.18	22	6	3.67	***
	high	10	0.45	8	15	0.53	--
F630	low	9	0.39	1	18	0.05	***
	med	5	0.22	3	10	0.30	--
	high	9	0.39	41	18	2.28	***
F709	low	17	0.65	5	13	0.38	***
	med	4	0.15	11	3	3.67	***
	high	5	0.19	4	4	1.00	--

1\ Bonferroni Z tests differ significantly from available: *** = $p < 0.01$

Table 6. Comparison of individual river otter habitat use and availability by disturbance category during spring in northwestern Montana. F610: $X^2 = 3.21$, df = 1, p = 0.073. F630: $X^2 = 0.79$, df = 1, p = 0.373. M709: $X^2 = 6.98$, df = 1, p = 0.008.

Otter	Disturb.	Avail. areas	Proportion available areas	Use observed (O)	Use expected (E)	Use index (O/E)	Sig.[1]
F610	absent	20	0.91	34	31	1.10	—
	present	2	0.09	0	3	0.00	—
F630	absent	18	0.78	39	35	1.11	—
	present	5	0.22	6	10	0.60	—
F709	absent	14	0.54	18	11	1.64	***
	present	12	0.46	2	9	0.22	***

1\ Bonferroni Z tests differ significantly from available:
*** = p < 0.01

Table 7. Comparison of individual river otter habitat use and availability during spring in northwestern Montana. Waterway obstruction: $X^2 = 17.61$, df = 1, $p < 0.01$. Understory: $X^2 = 16.08$, df = 3, $p = 0.01$. Shoreline: $X^2 = 31.04$, df = 2, $p < 0.001$. Disturbance: $X^2 = 10.80$, df = 1, $p < 0.001$

Variable	Category	Available areas	Proportion available areas	Use observed (O)	Use expected (E)	Use index (O/E)	Sig.[1]
Waterway	absent	20	.28	5	28	0.18	***
Obstruction	present	51	.72	94	71	1.32	***
	≤25	12	.17	4	17	0.24	**
Percent	26-50	26	.37	21	37	0.57	--
Understory	51-75	23	.32	53	32	1.66	**
	76-100	10	.14	21	14	1.50	--
Shoreline	low(11-24	34	.48	10	48	0.21	***
	med(25-30	13	.18	36	18	2.00	**
	high(>31)	24	.34	53	34	1.56	**
Disturbance	absent	52	.73	91	72	1.26	***
	present	19	.27	8	27	0.30	***

1\ Bonferroni Z tests differ significantly from available:
* = p < 0.1
** = p < 0.05
*** = p < 0.01

but 99% of these were rated as low disturbances. In available areas, 29% of the bridges and roads rated as moderate to high disturbances. Grazing and agriculture were rated moderate to high in 50% of AA and 100% of DMA.

Chi-square analysis showed females, but not male 709, used pools and waterway categories significantly different than available ($p < 0.001$) (Tables 8,9). Females preferred the same pool categories but used different waterway categories. In all waterways, female DMA contained a significantly greater amount of pools than AA (Table 8). Of the waterway categories, female 610 preferred sloughs and avoided creeks and the braided section of valley rivers while female 630 used ponds in significantly greater proportion than expected based on availability and avoided the main river (Table 9). The male, 709, used waterway categories in proportion to availability. The X^2 analysis of pools using the combined female otter locations was significant at $p < 0.01$.

In early April, female 630 began using her natal den: a muskrat (<u>Ondatra</u> <u>zibethica</u>) burrow and ground squirrel (<u>Spermophilus</u> sp.) tunnels at a pasture pothole 63 m from the river. No roll areas or trails were seen near 630's natal den but 6 old scats were found within 3 m after the family group left the site. On 4 occasions, 630 was seen stuffing grass into the entrance when she left the den. Female 630's pups were estimated to be 7 to 10 weeks old when they first emerged on 15 June. The pups were moved to a den site 2 km away on 17 June. During spring, female 610 associated with an unmarked otter, possibly her mother. This unmarked female was seen with 2 pups in late June.

Table 8. Comparison of individual river otter habitat use and availability by percent pools in the waterway during spring in northwestern Montana. F610: $X^2 = 18.81$, df = 1, $p < 0.001$. F630: $X^2 = 14.64$, df = 1, p = 0.001. M709: $X^2 = 0.011$, df = 1, p = 0.916.

Otter	Pools (%)	Available areas	Proportion available areas	Use observed (O)	Use expected (E)	Use index (O/E)	Sig.[1]
F610	0-50	10	0.45	1	15	0.07	***
	51-100	12	0.55	33	19	1.74	***
F630	0-50	14	0.61	7	27	0.26	***
	51-100	9	0.39	38	18	2.10	***
M709	0-50	16	0.62	12	12	1.00	--
	51-100	10	0.38	8	8	1.00	--

1\ Bonferroni Z tests differ significantly from available:
*** = $p < 0.01$

Table 9. Comparison of individual river otter habitat use and availability by waterway category during spring in northwestern Montana. F610: $X^2 = 21.16$, df = 1, $p < 0.001$. F630: $X^2 = 19.65$, df = 2, $p < 0.001$. M709: $X^2 = 0.71$, df = 2, $p > 0.2$. Waterway categories are R = river, S = slough, B/C = braided section of river/creek, P/L = pond/small lake.

Otter	Waterway category	Avail. areas	Proportion available areas	Use observed (O)	Use expected (E)	Use index (O/E)	Sig.[1]
F610	R	0	0.00	0	0	---	
	S	11	0.50	33	17	1.94	***
	B/C	11	0.50	1	17	0.06	***
	P/L	0	0.00	0	0	---	
F630	R	14	0.61	7	27	0.26	***
	S	6	0.26	8	12	0.67	--
	B/C	0	0.00	0	0	---	
	P/L	3	0.13	30	6	5.00	***
F709	R	17	0.65	13	13	1.00	--
	S	0	0.00	0	0	---	
	B/C	3	0.12	1	2	0.50	--
	P/L	6	0.23	6	5	1.20	--

1\ Bonferroni Z tests differ significantly from available:
*** = $p < 0.01$

Discriminant Function Analysis:

The following variables provided a strong contribution to group separation between otter and available habitat in spring: POOL, OBST, SHORE, UNDER. This model correctly classified 75% of the cases (Table 10). A higher percentage of available areas were misclassified as otter areas than vice versa. A DF model created with data from female otters' spring ranges correctly classified 91% of the female cases using the same 4 variables. Overall, 83% of the cases were correctly classified using this model (Table 11). The average prediction rate for each model was similar to the average classification rate (Tables 10, 11).

Habitat variables that distinguished otter daily movement areas from available areas in winter (November - February) were SHORE, OBST, DIST, and OVER; 72% of the cases were correctly classified (Table 12).

Standardized canonical discriminant function coefficients and classification rates for all 3 models are summarized in Table 12.

DISCUSSION

Home Range:

Home range shapes are primarily determined by drainage patterns (Melquist and Hornocker 1983) resulting in various ways for estimating otter home ranges. In areas with long, narrow drainage patterns, HRL have been measured by the distance along the waterway between the most distant locations (Melquist and Hornocker 1983, Mack 1985). In the extensive wetlands of Texas' coastal marshes, Foy (1984) used the minimum convex polygon (Mohr 1947, Southwood 1966) and nonparametric Fourier

Table 10. The number and percentage of river otter spring daily movement areas and available areas correctly classified and predicted by the 4 variable discriminant function analysis model (POOL, SHORE, OBST, UNDER).

	Areas classified by the model: Used	(% corr.) (class.)	Avail.	(% corr.) (class.)	Total classified
Used areas (% corr.)	79	(79.8)	20	(20.2)	99 (100.0)
(predicted)	(77.5)		(29.4)		
Avail. areas (% corr.)	23	(32.4)	48	(67.6)	71 (100.0)
(predicted)	(22.5)		(70.6)		
Total predicted	102 (100.0)		68 (100.0)		170

Table 11. The number and percentage of female river otter spring daily movement areas and available areas correctly classified and predicted by the 4 variable discriminant function analysis model (POOL, SHORE, OBST, UNDER).

	Areas classified by the model: Used	(% corr.) (class.)	Avail.	(% corr.) (class.)	Total classified
Used areas (% corr.)	72	(91.1)	7	(8.9)	79 (100.0)
(predicted)	(83.7)		(18.4)		
Avail. areas (% corr.)	14	(31.1)	31	(68.9)	45 (100.0)
(predicted)	(16.3)		(81.6)		
Total predicted	86 (100.0)		38 (100.0)		124

Table 12. Standardized canonical discriminant function coefficients and classification rates for habitat variables used by river otters versus available habitat variables in northwestern Montana.

Habitat variable	All otters winter	All otters spring	Female otters spring
POOL		0.623	0.888
SHORE	0.703	0.619	0.598
OBST	0.628	0.272	-0.116
UNDER		0.179	0.237
OVER	-0.033		
DIST	0.289		
% of DMA correctly classified	72.8	79.8	91.1
% of AA correctly classified	70.4	67.6	68.9
% of total correctly classified	71.7	74.7	83.06

transformation (Anderson 1982) methods. The latter deletes large areas only used infrequently and is less susceptible to sample size and distribution bias.

The technique of Melquist and Hornocker 1983 was the most appropriate for this study due to the area's drainage patterns. Otters cross pastures and promontories, sometimes traveling overland for up to 3 km (Melquist and Hornocker 1983, Dronkert and Grode 1984, Mack 1985). Such movements decrease travel distance compared with travel via waterway but the distance technique may still underestimate HRL because small meanders in the waterway are unmeasured. Despite these problems, this technique is useful in areas of long, narrow waterways because it has been used previously, and it is quick and simple.

Home range lengths observed in this study can be compared, in general, with HRLs obtained from studies in other mountain valleys in the West. In Grand County, Colorado, yearly HRL ranged from 5 km for an adult female to 71 km for an adult male (Mack 1985). The mean range for spring (March - May) was the same (15 km) as in my study. Mean range during the studies in Colorado and Montana was also fairly similar at 32 and 29 km, respectively. In west-central Idaho, seasonal HRL totals ranged from 10 to 81 km; in spring, an adult female with young had the smallest HRL at 15 km while an adult male ranged the longest at 50 km (Melquist and Hornocker 1983).

Home range is influenced by a number of factors and HRL values from other studies are presented only for general comparison. Although the habitats in the 3 study areas appear somewhat similar, detailed comparisons are infeasible due to variability in the type, amount, and time of data collection. Furthermore, accurate estimation of home range can require large numbers of locations to avoid an underestimation of home range from autocorrelation of locations (Swihart and Slade 1985). Two common trends can be seen; females had smaller HRL than males and total HRL varied greatly among otters. Females with new pups had the smallest home ranges; 82% of the locations of an Idaho female (Melquist and Hornocker 1983) and 100% of the locations of F630 in Montana were within 5 km of the natal den site. These trends require further investigation with statistically significant sample sizes.

Melquist and Hornocker (1983) hypothesized that otter HRL is defined primarily by the location of activity centers (areas where an otters was located at least 10% of the time in a season). In their study, activity centers were often located at the two outermost ends of the home range with the length between the centers used mainly for travel. Activity centers appear to harbor a relatively abundant complex of habitat components. Activity center size varies but in this study I choose an estimated, average daily movement area to investigate the complex of habitat components.

The number of locations used in this study to determine spring HRL appeared to give a reasonable estimation of home range for determining habitat availability; increases in HRL averaged less than 10% after 10 locations per otter were obtained.

Habitat Use:

Instrumented otters in the Flathead River Valley study area of northwestern Montana showed some strong patterns of habitat selection during the season of breeding, parturition, and lactation. A preference for areas with long shoreline lengths, greater than 25% understory bank cover, low disturbance factors, and the presence of waterway obstructions is similar to otter habitat selection in other parts of western North America (Melquist and Dronkert 1987). The spatial arrangement of waterways may have a strong influence on habitat use. Areas with a large proportion of shoreline related to water area were preferred by otters in this study. Such preference was probably due to concentrations of important habitat components. This emphasizes Lyon's (1985:1,2) suggestion that "habitat selection is generally considered to be a function of combined requirements for several habitat components in juxtaposition" and "habitat selection and use by an animal in the wild is the result of a continuous search for that combination of habitat components best able to satisfy daily requirements". If Lyon's suggestion is correct, then more waterways concentrated into an area would allow an otter to locate necessary habitat components with less traveling, hence minimizing energy expenditures. Intersecting, meandering or braided waterways should provide more concentrated foraging and resting sites, and probably greater otter densities, than waterways with few meanders and confluences.

Reservoirs and ponds with ample prey were avoided by Idaho otters if they lacked cover and resting sites (Melquist and Hornocker 1983). Understory cover was important to the otters in my study; areas with ≤ 25% understory bank cover were used significantly less than expected based on availability.

Otters in this study, as elsewhere (Melquist and Hornocker 1983), preferred the security and foraging areas provided by waterway obstructions. Logjams were used frequently in Idaho (accounting for 18% of the den and resting sites) (Melquist and Hornocker 1983). I did not test whether logjams and other obstructions (such as single logs or vegetation) in the waterway harbored higher concentrations of prey but they certainly could provide hiding cover for both predator and prey.

Although otters in this study preferred areas with low disturbance, all the grazing and agriculture disturbances in otter daily movement areas rated moderate to high, suggesting that otters have some tolerance for these disturbances.

Reproduction and Habitat Use:

The female otters in this study had the most distinct habitat preferences. The nutritional demands of gestation and lactation along with security needs are probably the primary influences on spring habitat selection.

River otters exhibit delayed implantation. In northwestern North America, females give birth from March through May following an average delay of 9 months (Liers 1951, Hamilton and Eadie 1964, Tabor 1974) and an actual gestation of about 62 days (Lancia and Hair 1983). Breeding follows parturition and females remain in estrus for more than 40 days (Liers 1958, 1960; Tabor 1974, Stenson 1985).

Sexual maturity is reached at 2 years of age but females may not breed at that time; only 20% of the 2-year-old females harvested in Minnesota during the 1983-84 trapping season (Berg 1984) and 55% of the 2-year-old females in a study in British Colombia (Stenson 1985) were pregnant. Females also may not breed every year (Lauhachinda 1978). Yearling female 610 probably did not breed. Female 630 and male 709 were of breeding age but it is unknown if either bred, although a biologist observed two otters mating within 709's home range in April. Female 630 gave birth in 1987 and although female 610 did not reproduce, her movements were associated with a female who did. Otter family groups consist of a female with pups and sometimes young from the previous year. Occasionally, a female of undetermined age will accompany the group and may function as a "nanny" (Melquist and Hornocker 1983).

Food resources probably have the greatest influence on habitat use (Melquist and Hornocker 1983). Large-scale suckers (Catostomus macrocheilus) were an important food source for Idaho otters during spring spawning and were probably a major factor in otters' high use of streams at that time. In the Flathead study area, suckers (C. macrocheilus or C. commersoni) were a minor food item while perch remains occurred in almost 50% of the otter scats collected in a previous study (Bissell and Bown 1987). Perch occur primarily in sloughs and ponds in the study area (G. Bissell, Montana Dept. of Fish, Wildl, and Parks, pers. commun.) and this important prey base may have been one primary reason females preferred these waterways. In Idaho, sloughs and marshes were important to family groups in summer, probably due to the abundant slow-moving fishes, such as bullheads (Ictalurus nebulosus) and perch (Perca flavescens), found in these areas (Melquist and Hornocker 1983).

Pools often harbor slower moving prey species and the female otters preference for areas with greater than 50% pools may be related to prey. This selection was also influenced by females' selection for ponds and sloughs that rated as 100% pooled.

Food may be a major factor in otter habitat use but adequate shelter is also necessary; 38% of the resting sites in Idaho were beaver bank dens or lodges (Melquist and Hornocker 1983). In the Flathead River, spring high water flooded many bank dens and probably made foraging difficult. Kerr Dam on the southern end of Flathead Lake maintained high water levels in the lower Flathead River until fall. This probably caused decreased otter use of the mainstem by flooding den and foraging sites.

Conversely, late spring low water in creeks and the braided section of the Flathead River exposed den sites. Although the braided section contained whitefish (Prosopium williamsoni), another important food item (Bissell and Bown 1987), both radiolocations and latrine surveys showed that otters left the braided area during high flows in April and May and had not returned by the end of June, possibly due to a lack of secluded dens. The number of resting sites may help define suitable habitat for mustelids such as marten (Martes americana) (Buskirk 1984) and mink (Mustela vison) (Birks and Linn 1972) as well as otter (Larsen 1983, Melquist and Hornocker 1983, Anderson and Woolf 1984).

Den sites are particularly important to reproducing females. Natal dens are often located away from the main waterway in natural cavities or the burrows of other animals (Reid 1982, Woolington 1984, Kruuk et al. 1987). In Alaska, natal dens were a minimum of 250 m from shore and commonly in hollow mounds left from decayed stumps (Woolington 1984). In the Flathead River valley, logging and agriculture have removed many potential natal den sites. Female 630's den site was more than 50 m from shore in a burrow created by another species but the area lacked natural vegetation. This may have forced female 630 to select a less than ideal den site in a cow pasture.

The river otter has few predators but location and secrecy may serve to guard against possible injury to pups from adult males (Melquist and Hornocker 1983, Woolington 1984). Breeding follows parturition so females may locate their young away from roaming, aggressive males. Female 630's behavior of stuffing grass into the den may have helped to disguise the den site and/or aided the pups thermoregulatory needs. Lutra lutra used grass and other vegetation in the natal den to provide good circulation (Wayre 1979). Natal dens generally show little evidence of occupation; no otter sign was found around dens in Alaska and Idaho (Melquist and Hornocker 1983, Woolington 1984). Although, female 630's natal den was difficult to detect, the presence of scats near the den differed from other studies. Territoriality in otters is rare and more often a defense of personal space but females may extend this to the natal den (nidic territoriality) (Melquist and Hornocker 1983) by actively defending their young if threatened.

Young are moved from the natal den to a rearing area when they are old enough to travel, from 5 to 12 weeks after parturition (Reid 1982, Melquist and Hornocker 1983, Woolington 1984); female 630 followed this pattern with her pups.

Discriminant Function Analysis:

The use of DFA for data exploration (rather than absolute prediction) allows one to investigate data that are less than optimally (normally) distributed (D. Patterson, pers. commun.). "Statistical procedures can be used to explore data whether underlying assumptions are met or not" (Williams 1983:1291). Exploratory methods can be informative and even an essential first step (Williams 1983).

Stepwise DFA is one of the most commonly used discriminant methods but it has some inherent problems. With any stepwise procedure, the more variables measured the greater the chance that some variable will be useful in separating categories. When using DFA, particularly stepwise DFA, a minimum of 4-5 times (D. Patterson, pers. commun.), or ideally 10 times (Edge 1985) as many samples as variables should be used. I choose to avoid stepwise DFA and used a minimum of 10 samples per variable.

Avoiding the trap of indiscriminant sampling, where one relies solely on DFA (or some other multivariate statistical method) to identify significant characteristics without reference to biological understanding, is imperative (Whitmore 1981:40 in Capen 1981, Edge 1985). Furthermore, determining the importance of a variable by the order of its coefficient is incorrect (Williams 1983:1289). Finally, DFA is a linear model and patterns of otter spring habitat use may not be linear (Noon 1984).

Variable selection is of primary importance. In this study, variable selection was based on 3 factors: 1) previous experience with river otters and their habitat i.e. "biological intuition"; 2) a concept of habitat as an optimal collection and/or juxtaposition of variables that fulfill an animal's life requirements; and 3) time and cost required to obtain the data on a variable. Edge (1985) pointed out that a higher degree of precision in variable measurement is necessary when studying a stenotopic species (one with very specific habitat requirements). Greater precision will also be required in a more homogeneous habitat. The river otter, while confined to water, is a generalist; and the waterways in the study area were not homogeneous. This allowed for less precision in variable measurements.

A higher proportion of waterway in pools, proportionally longer shorelines, and greater understory vegetation and waterway obstructions increased the likelihood of a site being classified as spring habitat. It is not surprising that these variables contributed to group separation for spring otter habitat. Pools, obstructions, and understory are habitat variables that are commonly used to describe good otter habitat (Melquist and Hornocker 1983, Dronkert and Grode 1984). These variables provide cover, den sites, and foraging areas in and along the waterway.

Although these habitat variables were important in distinguishing spring habitat for all the instrumented otters, they were of even greater importance in group separation for spring female otter habitat. A DF model created with the variables POOL, OBST, SHORE, and UNDER from females' ranges correctly classified 92% of the female DMA, illustrating the importance of these habitat characteristics to females in the study area.

The spring discriminant function model emphasized the same habitat variables found to be important using univariate statistical analysis. Overall classification rates of 75% and 83% for the all otter and female otter models, respectively, were good but not outstanding. These moderate classification rates probably resulted from the presence of adequate habitat areas that were documented as unused due to either the small sample size or because the otter population in the area has not reached its potential.

During winter (Nov-Feb) OVER and DIST replaced UNDER and POOL in the DF model. This change suggests that different habitat components were important to river otters during different seasons. Shoreline length and obstructions remained important throughout the study. Understory cover was not a major component of otter winter habitat, probably due to a lack of foliage. Instead, areas of 1 or no disturbances became a component of the habitat complex. The addition of pools to the spring model may indicate the importance of still water during high flows and may also reflect the need for an increase in food and security associated with reproduction.

Caution is advised when extrapolating DFA models to other areas; many species occupy a continuum of habitat which may not be adequately sampled in one localized study (Capen et al. 1984). These data were collected primarily in a valley riverine area from habitat use data based on 3 otters. Due to a small sample size and limited study area, the results of the DFA predictive model should be used cautiously in management. The model is best used as a preliminary model from which to test future river otter habitat use data.

Future data collection on otters should emphasize a wide range of occupied habitats. Non-use of an area may occur because not all habitat is saturated and not because the habitat is unsuitable (Capen et al. 1984:174). An animal's habitat requirements and tolerance for certain physical conditions may vary from one place to another and in relation to other species and conspecifics (O'Neil and Carey 1984). This, along with other factors such as weather changes and stochastic events, may confound species-habitat relationships.

MANAGEMENT RECOMMENDATIONS

Habitat use by otters in this study indicates that the following management practices would be prudent: maintain sloughs and ponds in the study area, discourage livestock or human destruction of the riparian vegetation, and insure bank stability for denning opportunities.

To better track the 1 otter harvest limit and to obtain important reproductive information, I recommend mandatory carcass collection within 48 hours of capture. A concerted effort to record trap location, to record age and sex of all otters, and to determine the reproductive status of female otters would provide useful biological and distributional data. Trappers should be required to carry a shield board in order to release otters captured over the 1 otter limit, although they should not be penalized if the otter is in a drown set or is severely injured and must be destroyed.

Until such time as otter latrines and sightings are documented throughout the waterways of northwestern Montana, I recommend restrictions on trapping on sloughs and ponds in the Flathead River Valley. In these areas, all furbearer trapping seasons should be closed after 1 March or live-trapping only restrictions for beaver should be implemented to avoid disturbing lactating female river otters.

A measure initiated in Britain (Chanin 1985) could be used to protect otter habitat. Owners of riparian areas have voluntarily agreed to manage their lands as "havens" for river otters. "Havens" are areas where development, human disturbance, and trapping are curtailed. Advice is given to landowners on management practices that are beneficial to otters such as fencing the riparian area or planting shrubs for cover. Practices such as these not only benefit the otter but also the entire riparian ecosystem. "Havens" are interspersed with legally protected nature reserves to provide a network of otter habitat.

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APPENDIX A

RIVER OTTER SIGN SURVEYS AND HABITAT ON 24 WATERWAYS IN NORTHWESTERN MONTANA

Surveys to determine otter habitat and distribution were conducted on 450 km of waterways in northwestern Montana from July 1985 through September 1986. Major waterways were identified (Fig. 1) and sections were randomly selected for surveys. Two otter sign and habitat belt transects were conducted at sites every 2.5 km along the waterway. One transect, 50 m long and 3 m wide, paralleled the high water line (2 m above and 1 m below). The other transect, 25 m long and 3 m wide, ran perpendicular to the first.

To determine habitat value ratings (HVR), I selected variables investigated for preference by river otters in previous work (Dronkert-Egnew in prep.). The values for each variable were averaged for a waterway section and given a rating from 1 (least preferred) to 3 (most preferred). These variable ratings were averaged to obtain a stream section score. Ratings from waterways with more than one surveyed section were then averaged to obtain an overall stream score. All ratings are given in Table 1.

River otter sign was found only on 7 transects, hence it was difficult to associate habitat value ratings with otter sign. Of the 5 streams with the highest HVR (≥ 2.5), 4 had sign on at least 1 transect. The 9 streams with the lowest HVR (≤ 1.9) showed no evidence of use by otters.

Otters are wide ranging and lack of sign during a single survey does

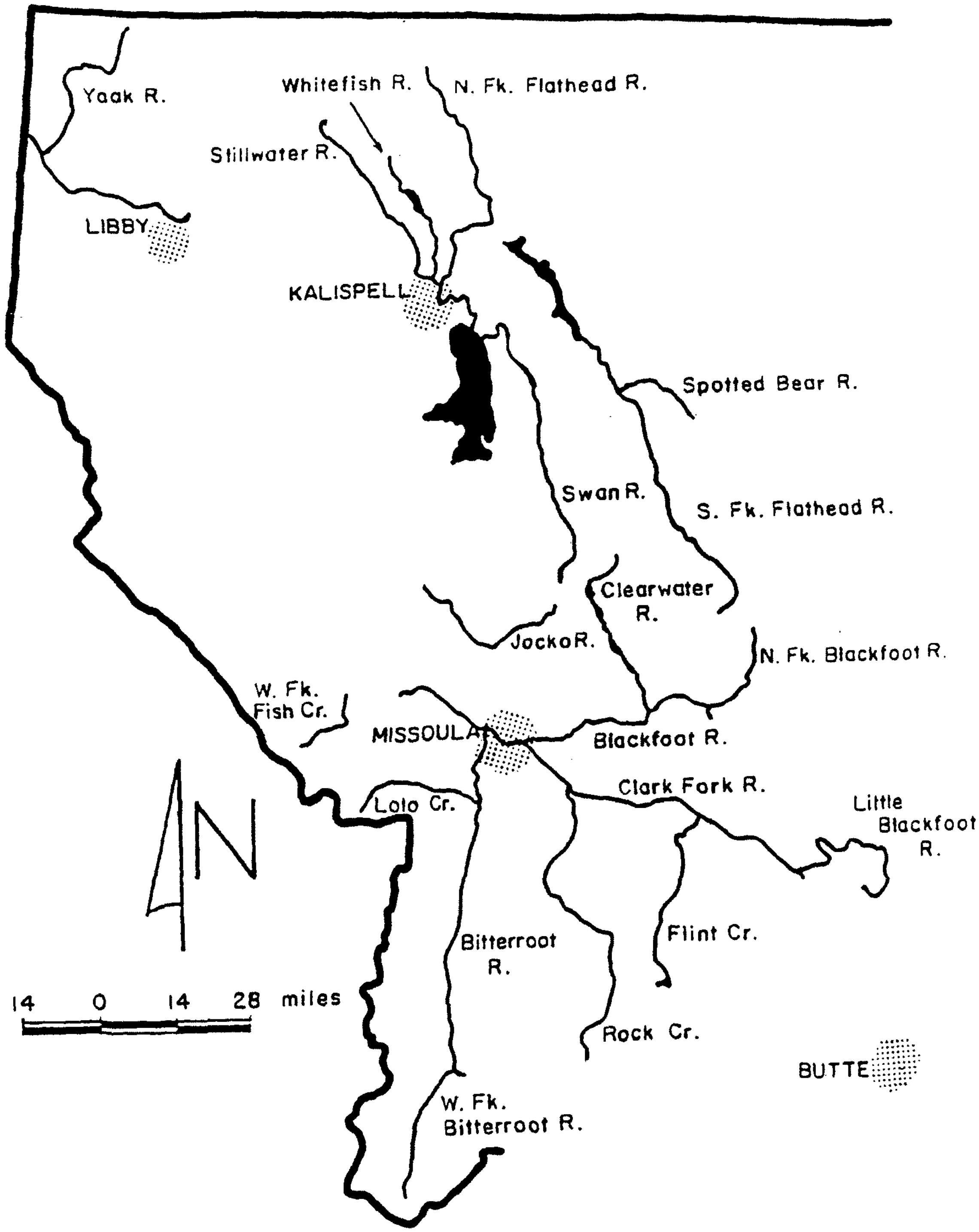

Fig. 1. Waterways surveyed for river otter sign and habitat in northwestern Montana.

not verify an absence of otters on the stream; nor do the HVR identify a level below which a stream is inadequate for otters. Finally, these surveys did not identify an essential component of otter habitat: prey base.

In summary, river otter sign was found on the Swan, Stillwater, Bitterroot, and Flathead Rivers. These rivers all had HVR of 2.5 and were second only to the Clearwater River with a HVR of 2.6. No otter sign was found on waterways with low HVR (< 2.0) including the Clark Fork, Blackfoot, and Kootenai Rivers, and Rock, Fish, and Lolo Creeks. Despite the low HVR and lack of sign, otters have been sighted on the Clark Fork and Blackfoot Rivers. This indicates these rivers may be suitable for otters but low amounts of preferred habitat may result in infrequent use of these waterways by otters. Rivers with ratings in the 2.0 to 2.4 range deserve additional survey work. The Whitefish River had a relatively low HVR (2.0) and otter sign. The North Fork of the Flathead and Spotted Bear Rivers both had possible sign that was too faint to verify. The Yaak, Spotted Bear, and North and South Forks of the Flathead Rivers should provide suitable habitat for river otters but may support lower densities than rivers with ratings of 2.5 and above.

Table 1. Stream suitability for river otters based on 4 habitat variables in northwestern Montana. Depth: < 100 cm = 1, 100-200 m = 2, > 200 m = 3. Meander: ≤ 1.1 = 1, 1.2-1.3 = 2, > 1.3 = 3. Velocity: Fast = 1, Moderate = 2, Slow = 3. Bank Cover: ≤ 25% = 1, 26-50% = 2, > 50% = 3. Otter sign on any transect on a section was recorded as a yes for the waterway. Unconfirmed otter sign was recorded as Possible.

Waterway Section	Stream Depth	Stream Meander	Stream Velocity	Bank Cover	Section Score	Stream Score	Otter Sign
Clearwater River							
- Rainy Lake to Alva inlet	2	3	2	2	2.3	2.6	---
- Clearwater Add. Bridge to Placid Lake Rd.	2	3	3	3	2.8		
Swan River							
- Headwaters to below Condon	1	3	2	2	2.0	2.5	Yes
- Porcupine Br. to Swan Lake	3	3	3	3	3.0		
Stillwater River	2	2	3	3	2.5	2.5	Yes
Bitterroot River							
- Bell Junction to Stevensville	2	1	3	2	2.0	2.5	Yes
- Lee Metcalf to Florence Br.	3	3	3	3	3.0		
Flathead River							
- above Kalispell	3	2	2	3	2.5	2.5	Yes
Yaak River							
- above Yaak Mercantile	3	2	3	3	2.8	2.4	---
- Hwy. 508 marker 22 - 18	2	1	3	2	2.0		
Flint Creek	3	3	2	1	2.3	2.3	---
- Phillipsburg area							
South Fork of the Flathead River							
- Meadow Creek to Spotted Bear	3	3	2	1	2.3	2.1	---
- Big Salmon Lake area	3	1	2	1	1.8		

Spotted Bear Rvr.	1	3	2	2	2.0	2.0	Pos.
North Fork of the Flathead River - downstream of Polebridge	2	2	2	2	2.0	2.0	Pos.
Little Blackfoot	1	2	3	2	2.0	2.0	---
Whitefish River - Whitefish Lake area	1	2	3	2	2.0	2.0	Yes
Blackfoot River - near Ovando	2	2	2	2	2.0	1.9	---
- Johnsrud Park area	1	2	2	2	1.8		
Rock Creek - West Fork to Hogback Creek	1	2	2	2	1.8	1.8	---
- Siria Camp to Interstate 90	1	2	1	3	1.8		
North Fork of the Blackfoot River	2	2	2	1	1.8	1.8	---
Clark Fork River - Garrison to Phosphate	1	2	2	1	1.5	1.8	---
- Drummond to Bearmouth	1	2	3	2	2.0		
- Schwarz Creek to Turah	2	2	2	2	2.0		
Kootenai River - Fisher River to Troy	3	1	1	2	1.8	1.8	---
Fish Creek - West Fork to Clark Fork	1	2	1	3	1.8	1.8	---
Jocko River - above Arlee	1	3	1	2	1.8	1.8	---
West Fork of the Bitterroot River	1	1	2	2	1.5	1.5	---
Lolo Creek	1	2	1	2	1.5	1.5	---

APPENDIX B

Morphometric measurements of river otters captured in the Flathead River Valley, northwestern Montana. Age Class: Yrling = Yearling. All length and circumference measurements are in centimeters.

ID No.	Sex	Age Class	Weight (kg)	Total Length	Tail Length	Hindfoot Length	Ear Length	Head Circ.	Neck Circ.	Chest Circ.
870	F	Adult	7.62	118.0	46.0	13.0	2.0	29.0	29.0	39.0
740	M	Adult	7.62	111.0	45.0	11.8	1.7	28.0	30.5	39.0
610	F	Yrling	7.17	107.5	45.5	12.5	1.5	29.5	29.0	39.0
630	F	Adult	8.51	118.0	50.0	12.5	1.9	27.0	28.5	41.5
710	M	Adult	9.41	119.5	53.0	12.7	1.8	29.2	30.3	43.5